CASCaDE: Computational Assessments Of Scenarios Of Change For The Delta Ecosystem

prepared by Cloern, James E

submitted to Science Program 2004

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Project

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004−12−27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

Instructions

Information provided on this form will automatically support subsequent forms to be completed as part of the Science PSP submission process. Please be mindful of what information you enter and how it may be represented in the Personnel, Task and Budget forms. Please provide this information before continuing to those forms.

Proposal Title	***CASCaDE: Computational Assessments of Scenarios of Change for the Delta Ecosystem***	
Institutions	United States Geological Survey Scripps Institute of Oceanography	*List each institution involved, one per line.*
Proposal Document		*You have already uploaded a proposal document. View it to verify that it appears as you expect. You may replace it by uploading another document*
Project Duration	***36 months***	

Is the start date a determining factor to the successful outcome of the proposed effort?
− No.
X Yes. Anticipated start date of this effort: ***2006−01−01***

Select all of the following study topics which apply to this proposal.
X life cycle models and population biology of key species
X environmental influences on key species and ecosystems
X relative stresses on key fish species
X direct and indirect effects of diversions on at−risk species
X processes controlling Delta water quality
X implications of future change on regional hydrology, water operations, and environmental processes
− water management models for prediction, optimization, and strategic assessments
− assessment and monitoring
− salmonid−related projects
− Delta smelt−related projects

Select as many keywords as necessary to describe this proposal (minimum of 3).
X adaptive management
X aquatic plants
X benthic invertebrates
X biological indicators
− ***birds***
− neotropical migratory birds
− shorebirds
− upland birds
− wading birds
− waterfowl
X climate
X climate change
X precipitation
X sea level rise
X snowmelt
X contaminants / toxicants / pollutants
− contaminants and toxicity of unknown origin
− emerging contaminants
X mercury
− nutrients and oxygen depleting substances
− organic carbon and disinfection byproduct precursors
− persistent organic contaminants
− pesticides
X salinity

X sediment and turbidity
X selenium
X trace metals
− ***database management***
− ***economics***
− ***engineering***
− civil
X environmental
X hydraulic
− ***environmental education***
− ***environmental impact analysis***
− ***environmental laws and regulations***
− ***environmental risk assessment***
− ***fish biology***
− bass and other centarchids
− delta smelt
− longfin smelt
− other species
− salmon and steelhead
− splittail
− striped bass
− sturgeon
− ***fish management and facilities***
− hatcheries
− ladders and passage
− screens
− ***forestry***
− ***genetics***
X geochemistry
− ***geographic information systems (GIS)***
X geology
X geomorphology
− ***groundwater***
X habitat
X benthos
X channels and sloughs
X flooded islands
X floodplains and bypasses
X oceanic
− reservoirs
− riparian
X rivers and streams
X shallow water
− upland habitat
− vernal pools
X water column
X wetlands, freshwater
X wetlands, seasonal
X wetlands, tidal
− ***human health***
X hydrodynamics
X hydrology
− ***insects***
X invasive species / non−native species / exotic species
X land use management, planning, and zoning
X limnology
− ***mammals***
− large
− small
− ***microbiology / bacteriology***
X modeling
X conceptual
X quantitative
− ***monitoring***
X natural resource management

− ***performance measures***
X phytoplankton
X plants
X primary productivity
− ***reptiles***
X restoration ecology
− ***riparian ecology***
X sediment
− ***soil science***
− ***statistics***
− ***subsidence***
X trophic dynamics and food webs
X water operations
X barriers
X diversions / pumps / intakes / exports
X gates
X levees
X reservoirs
X water quality management
X ag runoff
− mine waste assessment and remediation
− remediation
X temperature
− urban runoff
− water quality assessment and monitoring
− ***water resource management***
X water supply
− demand
− environmental water account
− water level
− water storage
X watershed management
− ***weed science***
− ***wildlife***
− ecology
− management
− wildlife−friendly agriculture
− ***zooplankton***
− ***administrative***

Indicate whether your project area is local, regional, or system−wide. If it is local, provide a central ZIP Code. If it is regional, provide the central ZIP Code and choose the counties affected. If it is system−wide, describe the area using information such as water bodies, river miles, and road intersections.	
− local	ZIP Code:
− regional	ZIP Code: counties:
X system−wide	Geographic scope of this project includes the San Francisco Bay−Delta ecosystem, its tributary rivers, their watersheds, and the regional climate domain that influences hydrology of those watersheds.

Does your project fall on or adjacent to tribal lands?
No.

(Refer to California Indian reservations to locate tribal lands.)
If it does, list the tribal lands.

Has a proposal for this effort or a similar effort ever been submitted to CALFED for funding or to any other public agency for funding?
No.

If yes, complete the table below.

Status Proposal Title Funding Source Amount Comments

Has the lead scientist or principal investigator of this effort ever submitted a proposal to CALFED for funding or to any other public agency for funding? ***Yes.***

If yes, provide the name of the project, when it was submitted, and to which agency and funding mechanism if was submitted. Also describe the outcome and any other pertinent details describing the proposal's current status.

The Principal Investigators have previously received funds from CALFED to support the following research projects:

−− Title: Assessment of the Sacramento−San Joaquin River Delta as Habitat for Production of the Food Resources that Support Fish Recruitment Dates: 1 April 1998 – 30 September 2001 Lead Investigator(s): James E. Cloern Funding Agency/Mechanism: CALFED Bay Delta Environmental Enhancement Act, funding through USBR Contract Number: 1425−98−AA−20−16240 Status: Completed Products: Articles in Scientific Journals: Jassby, A.D. and J.E. Cloern. 2000. Organic matter sources and rehabilitation of the Sacramento−San Joaquin Delta (California, USA). Aquatic Conservation: Marine and Freshwater Ecosystems 10: 323−352. Cloern, J.E., E.A. Canuel, D. Harris. 2002. Stable carbon and nitrogen isotope composition of aquatic and terrestrial plants of the San Francisco Bay estuarine system. Limnology and Oceanography 47: 713−729. Jassby, A.D., J.E. Cloern, B.E. Cole. 2002. Annual primary production: patterns and mechanisms of change in a nutrient−rich tidal ecosystem. Limnology and Oceanography 47: 698−712. Lucas, L.V., J.E. Cloern, J.K. Thompson, N.E. Monsen. 2002. Functional variability of habitats within the Sacramento−San Joaquin Delta: restoration implications. Ecological Applications 12: 1528−1547. Mueller−Solger, A.B., A.D. Jassby and D.C. Mueller−Navarra. 2002. Nutritional quality of food resources for zooplankton (Daphnia) in a tidal freshwater system (Sacramento−San Joaquin River Delta, USA). Limnology and Oceanography 47: 774−777. Sobczak, W.S., Cloern, J.E., Jassby, A.D and Mueller−Solger, A. 2002. Bioavailability of organic matter in a highly disturbed estuary. The role of detrital and algal resources. Proceedings of the National Academy of Sciences 99: 8101−8105. Monsen, N.E., Cloern, J.E., Lucas, L.V., and Monismith, S.G. 2002. A comment on the use of flushing rate, residence time and age as transport time scales. Limnology and Oceanography 47: 1545−1553. Jassby, A.D., J.E. Cloern, A. Mueller−Solger. 2003. Phytoplankton fuels the food web in Delta waterways. California Agriculture 57:104−109. Sobczak, W.V., J.E. Cloern, A.D. Jassby, B.E. Cole, T.S. Schraga, and A. Arnsberg. Detritus fuels ecosystem metabolism but not metazoan foodwebs in San Francisco Estuary's freshwater Delta. Estuaries, in press.

Articles in Agency Newsletters: J.E. Cloern, 1999, "A CALFED−Supported Study of the Delta's Foodweb Base", IEP Newsletter 12(1): 19−20 E.A. Canuel, 1999, "Sources of Organic Matter in the Delta as Inferred through the use of Biomarkers", IEP Newsletter 12(1): 20−21 A. Mueller−Solger, 1999, "Food Quantity and Quality for Zooplankton in the Sacramento−San Joaquin Delta", IEP Newsletter 12(3): 32−33 N.E. Monsen, 1999 "Calibration and Verification of Delta TRIM", IEP Newsletter 12(4): 28−34 12(4) "Puzzling Over the Shallows", CALFED Bay−Delta Science Program Science In Action, December 2001 issue of Estuary, San Francisco Estuary Project A.E. Jassby and J.E. Cloern, 2000, "Primary Food Resources in the Sacramento−San Joaquin Delta", IEP Newsletter 13(3): 21−25

Presentations: Cloern, J.E., "Basic Science in Support of Ecosystem Restoration: Lessons from a Research Program Supported by CALFED Category III", CALFED Science Conference, October 2000 Mueller−Solger, A., K. Forshay D. Mueller−Navarra, "FOOD QUANTITY AND QUALITY FOR DAPHNIA IN THE SACRAMENTO−SAN JOAQUIN DELTA ESTUARY", CALFED Science Conference, October 2000 Jassby, A.D., " Organic Matter Sources for the Delta's Food Web", CALFED Science Conference, October 2000 Monsen, N.E., S.G. Monismith, " Impact of Temporary Barriers and Flow through the Yolo Bypass on the Transport of Organic Carbon through the Delta", CALFED Science Conference, October 2000 Lucas, L.V., J.E. Cloern, J.K. Thompson, "SPATIAL VARIABILITY IN ECOLOGICAL FUNCTION BETWEEN AND WITHIN FLOODED ISLANDS: LESSONS FOR RESTORATION AND MONITORING", CALFED Science Conference, October 2000 Canuel, E.A.,V. Pilon, M. Ederington−Hagy, " SOURCES OF ORGANIC MATTER IN THE SACRAMENTO−SAN JOAQUIN RIVER DELTA AS INFERRED THROUGH THE USE OF BIOMARKERS", CALFED Science Conference, October 2000 Sobczak, W.V., J. E. Cloern, B.E. Cole, T. Schraga, A. Arnsberg, J. Edmunds, "Organic Matter Bioavailability among Habitats and Hydrologic Inputs in the Sacramento and San Joaquin River Delta", CALFED Science Conference, October 2000 N.E. Monsen, "Impact of Temporary Barriers and the Yolo Bypass on Transport of Organic Carbon Through the Delta" CALFED Science Conference, October 2000 N.E. Monsen ,"Transport Mechanisms for Water and Scalars in the Delta" CALFED Science Conference, October 2000 (Best Student Presentation Award) Cloern, J.E., "Basic research in support of ecosystem restoration", AAAS Annual Meeting, San Francisco, Special Session "Role of Science in the Water Issues of Northern California", February 2001. Cloern, J.E., "Constraints on primary and secondary production: implications for ecosystem restoration", American Fisheries Society California−Nevada Chapters, Santa Rosa, CA. Special Session "Opportunities and Constraints in the Restoration of the Bay−Delta Watershed", March 2001. Nancy Monsen and Bill Sobczak participated in the Delta Studies Curriculum Project which was held at the San Joaquin County Office of Education in March 2001. Bill Sobczak presented a lecture on "Ecosystem Restoration and Delta Food Webs". J.E. Cloern, "Integrated Science in Support of Ecosystem Restoration: An Example from the San Francisco Bay−Delta", 16th Biennial Conference of the Estuarine Research Federation, Tampa, FL, November 2001. W.V. Sobczak, "Assessment of organic matter bioavailability among habitats and hydrologic inputs in the Sacramento and San Joaquin River Delta", American Society of Limnology and Oceanography 2000 Meeting, Copenhagen, Denmark. W.V. Sobczak, "Bioavailability of organic matter in a highly disturbed estuary: Implications for ecosystem restoration", Estuarine Research Federation Meeting 2001,Tampa, FL. N.E. Monsen, "Transport Timescales: No Two Approaches are Alike", Ocean Sciences (ASLO/AGU), February, 2002, Honolulu, HI N.E. Monsen, "The Importance of Tidal Dispersion with Application to the Sacramento−San Joaquin Delta, CA", Estuarine Research Federation (ERF) Conference, November 2001, St. Pete Beach, FL

L.V. Lucas, "Frank and Millie's Secrets Revealed: Comparison of 'Similar' Shallow Tidal Habitats in the Sacramento−San Joaquin River Delta." (Poster) Annual meeting of the Interagency Ecological Program, Asilomar, California, February 27−29, 2002. J.E. Cloern, "Science in Support of Ecosystem Restoration: A Tribute to Aretha Franklin", CALFED Bay−Delta Program Science Conference, January 2003, Plenary Keynote Address

Video Documentary: "Delta Revival: Restoring a California Ecosystem", produced by USGS and the CALFED Bay Delta Authority. The show was broadcast in August 2003 by the San Francisco CBS affiliate KPIX. It was shown as a USGS Western Region Public Lecture on 27 May 2004 (http://online.wr.usgs.gov/calendar/). Copies of the DVD have been sent to classrooms, researchers, and government agencies around the US. The documentary received a 2003 Golden Screen Award from the National Association of Government Communicators.

−− Title: How does the Delta work? Understanding fundamental hydrodynamic and transport mechanisms for modeling, monitoring, and management Dates: 1 June 2001 – 30 September 2005 Lead Investigator(s): L.V. Lucas (USGS, Menlo Park), J.R. Burau (USGS, Sacramento), S.G. Monismith (Stanford University), N.E. Monsen (USGS, Menlo Park), M.T. Stacey (UC Berkeley) Funding Agency/Mechanism: CALFED Bay Delta Environmental Enhancement Act, funding through USBR and DWR Contract Number: Lucas032001 Status: Currently funded

Products: Articles in prep. for Scientific Journals:

Monsen, N.E., J.E. Cloern, J.R. Burau. "Water diversion as an ecosystem disturbance: examples from the Sacramento−San Joaquin River Delta, California," submitting to Water Resources Research by January 15, 2005. (USGS internal review completed) Fong, D.A., S.G. Monismith, J.R. Burau, and M.T. Stacey, "Secondary circulation and bottom stresses in an unstratified tidal channel with significant curvature", Journal of Hydraulic Engineering (in prep).

Presentations: Monsen, N.E. "Water diversion as an ecosystem disturbance: Four examples from the Delta", CALFED Science Conference, October, 2004 Monsen, N.E. "Lessons learned from specific Delta habitats: when, where, and how I use a multidimensional model", California Water and Environmental Modeling Forum, February, 2004. Burau, J.R., "Intertidal timescale transport in a tidally influenced network of channels – examples from the Sacramento/San Joaquin Delta, California, USA", 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA. Fong, D.A., Monismith, S.G., Burau, J.R., Stacey, M.T., "Secondary currents and turbulent mixing in a curved estuarine channel", 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA.

Expected major products:

Hydrodynamics Workshop to be held in August, 2005 in Sacramento to explain circulation and mixing in the Delta. A hydrodynamics manual will also be produced related to the workshop. The chapters in this manual will be written in journal format so that they can be submitted to peer reviewed journals for publication.

−− Title: Hydroclimatic Reconstruction and Ancient Blue Oak Mapping over the Drainage Basin of San Francisco Bay Dates: January 2004 – September 2006 Lead Investigator(s): David H Stahle, University of Arkansas Funding Agency/Mechanism: CBDA Ecosystem Restoration Program Agreement Contract Number: ERP−02−P30 Status: In progress Products: Scientists from four universities and the US Geological Survey (USGS) have recently undertaken a 3−year research project to characterize the geographic distribution of ancient blue oaks in the drainage basin of San Francisco Bay, and to use treering widths from roughly 50 groves of these trees to reconstruct precipitation and streamflow variations around the Central Valley during the past 500 years. The oaks are among the finest recorders of precipitation yet found by treering researchers, and thus will be used to reconstruct hydroclimatic conditions in as many separate river basins as possible. USGS researchers will focus mostly on developing statistical reconstructions of precipitation and river discharge.

New treering cores and width series have already been developed from a half dozen oak groves. Initial comparisons of treering widths to river discharges in the Kern and Salinas River basins have been made and are encouraging. They appear to confirm the remarkable value of ring−widths from this particular species as precipitation recorders, reported previously by the investigators (Stahle et al 2001). More detailed river−by−river reconstructions await the completion of additional ring−width chronologies. Results of the mapping and reconstruction efforts will be published in peer reviewed journals as they are developed.

[Stahle, D.W., Therrell, M.D., Cleaveland, M.K., Cayan, D.R., Dettinger, M.D., and Knowles, N., 2001, Ancient blue oaks reveal human impact on San Francisco Bay salinity: Eos, 82, 141, 144−145.]

−− Title: CALFED Climate−change White Paper Dates: October 2002 – present Lead Investigator(s): Michael Dettinger Funding Agency/Mechanism: USBR Investigations and Studies related to the CALFED Bay−Delta Program Contract Number: USBR 02−AA−200111 Status: In progress (nearing completion) Products: 1. Published: Dettinger, M.D., Bennett, W., Cayan, D.R., Florsheim, J., Hughes, M., Ingram, B.L., Knowles, N., Malamud, F., Peterson, D.H., Redmond, K., and Smith, L., 2003, Climate science issues and needs of the CALFED Bay−Delta Program (abs.): 2nd Biennial CALFED Science Conference, Sacramento, Jan. 2003. Dettinger, M.D., Bennett, W.A., Cayan, D.R., Florsheim, J., Hughes, M., Ingram, B.L., Jassby, A., Knowles, N., Malamud, F., Peterson, D.H., Redmond, K., and Smith, L., 2003, Climate science issues and needs of the CALFED Bay−Delta Program: American Meteorological Society, 83rd Annual Meeting, Impacts of Water Availability Symposium, Long Beach, CA, Feb. 2003, 7.11−1 to 7.11.4. Dettinger, M.D., 2004, Characterizing the uncertainties associated with 21st Century climate projections for California (abs.): 3rd Biennial CALFED Science Conference, Sacramento, CA, October 2004. Dettinger, M.D., 2004, From climate−change spaghetti to climate−change distributions for 21st Century California: San Francisco Estuary and Watershed Science, 35 p. Florsheim, J.L., and Dettinger, M.D., 2004, Influence of anthropogenic alterations in geomorphic response to climate variations and change in San Francisco Bay, Delta and watershed? (abs.): American Geophysical Union Fall 2004 Meeting, San Francisco. Florsheim, J.L., Dettinger, M.D., Hughes, M., Ingram, B.L., Malamud−Roam, F., and Mount, J.F., 2004, Projected geomorphic response to future climate variability and change in lowland rivers, San Francisco Bay−Delta watershed, CA (abs.): Geological Society of America Annual Meeting, Denver, CO. Malamud−Roam, F., Ingram, B.L., Hughes, M., and Florsheim, J., 2004, Late Holocene paleoclimate records from the San Francisco Bay estuary and watershed, California California (abs.): 3rd Biennial CALFED Science Conference, Sacramento, CA, October 2004. 2. Soon to come: Dettinger, M.D., in review, A component−resampling approach

for estimating probability distributions from small forecast ensembles: Climatic Change, 31 p. Malamud−Roam, F., Ingram, B.L., Hughes, M., and Florsheim, J., in review, Late Holocene paleoclimate records from the San Francisco Bay estuary and watershed, California: for submission to Quaternary Research. 3. Final products: Malamud−Roam, F. , Ingram, B.L., Dettinger, M., Hughes, M., and Florsheim, J., in final preparation, Climate science issues and needs of the CALFED Bay−Delta Program—I, Paleoclimatic variations of the San Francisco Bay estuary and watershed with implications for the future climate: for submission to San Francisco Estuary and Watershed Science. Dettinger, M.D., Knowles, N., Cayan, D.R., Redmond, K.T., Florsheim, J., and Bennett, W., in final preparation, Climate science issues and needs of the CALFED Bay−Delta Program—II, 21st Century climate projections: for submission to San Francisco Estuary and Watershed Science. Dettinger, M.D., Knowles, N., Cayan, D.R., Redmond, K.T., Florsheim, J., and Bennett, W., in preparation, Climate science issues and needs of the CALFED Bay−Delta Program—III, Historical climate variations and observations, with overarching recommendations: for submission to San Francisco Estuary and Watershed Science.

−−− Title: Effects of Climate Variability and Change on the Vegetation and Hydrology of the Bay−Delta Watershed Dates: 1 November 2003 – 31 October 2006 Lead Investigator(s): Noah Knowles Funding Agency/Mechanism: CALFED Ecosystem Restoration Program Contract Number: CBDA Project No. ERP−02−P38 CBDA/Recipient Agreement No. 4600002881 Status: In progress Products: In progress

−− Title: Transport, Transformation and Effects of Selenium and Carbon in the Delta of the Sacramento−San Joaquin Rivers: Implications for Ecosystem Restoration Dates: 15 July 2001 – 14 June 2005 Lead Investigator(s): Sam N. Luoma, James E. Cloern Funding Agency/Mechanism: Resources Agency/California Bay−Delta Program Contract Number: 4600001955 Status: In progress Products: Articles in Scientific Journals: Baines, S.B., N.S. Fisher and R. Stewart. 2002. Assimilation and retention of selenium and other trace elements from crustacean food by juvenile striped bass (Morone saxatilis). Limnology and Oceanography 47: 646−655. Lucas, L. V. and J. E. Cloern. 2002. Effects of tidal shallowing and deepening on phytoplankton production dynamics. Estuaries 25(4A): 497−507. May, C., J. R. Koseff, L. V. Lucas, J. E. Cloern, and D. H. Schoellhamer. 2003. Effects of spatial and temporal variability of turbidity on phytoplankton blooms. Marine Ecology Progress Series, 254, 111−128. Baines, S.B., Doblin, M.A., Cutter, G.S., Cutter, L.S., Cole, B.E., and Fisher N.S. 2004. Light dependence of Se uptake by phytoplankton and implications for predicting selenium incorporation into food webs. Limnology and Oceanography 49(2): 566−578. Doblin, M.A., Baines, S.B., Cutter L.S., and Cutter, G.A. The biogeochemistry of selenium in San Francisco Bay: seston and phytoplankton. In review, Estuarine, Coastal and Shelf Science. Lucas, L.V., D. M. Sereno, J.R. Burau, T. Schraga, C.B. Lopez, M. T. Stacey, K. Parchevsky, and V. Parchevsky. High frequency variability in a small tidal habitat: indications of underlying processes. In review, Limnology and Oceanography. Lopez, C.B., Little, A.J., Schraga, T., Lucas, L.V., and Cloern, J.E. Ecological Values of Shallow−Water Habitats: Implications for Restoration of Disturbed Ecosystems. In review, Ecosystems. Meseck, S.C. and G.A. Cutter. Simulating the estuarine biogeochemistry of selenium: results from the heavily modified San Francisco Bay. In prep., to be submitted to Limnology and Oceanography. Doblin, M.A., L.S. Cutter, G.A. Cutter, and S. B. Baines. Transformation and cycling of nutrients and selenium in a semi−enclosed freshwater ecosystem. In prep., to be submitted to Limnology and Oceanography. Sereno, D. M. and Stacey, M. T. “Exchanges between vegetated and unvegetated subhabitats within a shallow tidal system.” In prep. Sereno, D. M., Baek, S. and Stacey, M. T. “Wind−driven and density−driven circulation in a shallow tidal basin.” In prep. Thompson, J.K., Stewart, A.R., Parchaso, F., Burau, J.R., and Schoellhamer, D. Benthic grazer food sources in North San Francisco Bay as defined by bivalve growth, stable isotopes, and physical processes. In prep., to be submitted to Limnology and Oceanography. Parchaso, F. and Thompson, J. Distribution and grazing potential of Corbicula fluminea in the Sacramento−San Joaquin Delta. In prep., to be submitted to San Francisco Estuary and Watershed Science. Baines, S.B. and N.S. Fisher. Evidence of a specific and non−specific selenite uptake pathway in phytoplankton and implications for management. In prep., to be submitted to Environmental Science and Technology. Baines, S.B. and N.S. Fisher. Factors affecting accumulation of organic and inorganic Se by aerobic bacteria. In prep., to be submitted to Limnology and Oceanography. Baines, S.B., Twining B.T. and N.S. Fisher. Use of synchrotron−based x−ray fluorescence microscopy (SXRF) to measure Se and As in phytoplankton cells. In prep., to be submitted to Limnology and Oceanography Methods. Stewart, A.R., Luoma, S.N. Resolving contaminant variability in migratory predators. In prep. Stewart, A.R., Luoma, S.N., Doblin, M.A. and Grimaldo, L. Selenium bioaccumulation in shallow−water habitats of the Sacramento/ San Joaquin Delta. In prep.

Articles in Agency Newsletters: Rubissow−Okamoto, A., and many others. 2001. “Science in Action: Puzzling over the Shallows.” Newsletter, CALFED Bay−Delta Program &San Francisco Estuary Project. Lucas, L.V., T. Schraga, C.B. Lopez, J.R. Burau, and A.D. Jassby. 2002. Pulsey, Patchy Water Quality in the Delta: Implications for Meaningful Monitoring. Newsletter, Interagency Ecological Program for the Sacramento−San Joaquin Estuary, 15(3), 21−27. Orsi, J. J. 2002. Zooplankton production in shallow water and channel habitats: an example from Mildred Island. IEP Newsletter, Summer: 27−32.

Presentations: Lucas, L.V., “Delta phytoplankton dynamics: time scales, spatial scales, and processes of variability”, IEP Organic Matter Estuarine Ecology Team Meeting, August 2002, Tiburon, California. Lucas, L.V., “Unraveling variability and revealing uncertainty: a role for science in ecosystem restoration”, USGS−WRD seminar, November 2002, Menlo Park, CA. Lopez, C.B., T.S. Schraga, “Revealing Patterns of Phytoplankton Dynamics in a Delta Habitat: A Billion Diatoms Can't Be Wrong!”, USGS−WRD seminar, December 2002, Menlo Park, CA. Lucas, L.V., “Unraveling variability and revealing uncertainty: a role for science in ecosystem restoration”, UC Berkeley Civil Engineering Graduate seminar, November 2002, Berkeley, CA. Baines, S.B., N.S. Fisher, L.S. Cutter, M.A. Doblin, G.A. Cutter, “Ratios of selenite and C uptake in suspended phytoplankton: implications for prediction of Se incorporation into food−webs”, CALFED Science Conference, January 2003, Sacramento, CA. Burau, J.R., J.I. Cuetara, C.A. Ruhl, R.L. Dinehart, J.E. George, “Effects of the tides, geometry, meteorology, and project operations on circulation and mixing in a flooded island environment: lessons from Mildred Island”, CALFED Science Conference, January 2003, Sacramento, CA. Cutter, G.A., L.S. Cutter, S.L. Meseck, M.A. Doblin, “Dissolved and particulate selenium dynamics in Mildred’s Island: biotic controls on a trace element cycle”, CALFED Science Conference, January 2003, Sacramento, CA. Doblin, M.A., L.S. Cutter, and G.A. Cutter, “Biogeochemical cycling of nutrients and trace elements in flooded island habitats”, CALFED Science Conference, January 2003, Sacramento, CA. Lopez, C.B., L.V. Lucas, J.E. Cloern, T.S. Schraga, “Spatial variability of phytoplankton dynamics in a tidal flooded island”, CALFED Science Conference, January 2003, Sacramento, CA. Meseck, S., G.A. Cutter, “Modeling the biogeochemical cycle of selenium in the San Francisco Bay”, CALFED Science Conference, January 2003, Sacramento, CA. Monsen, N.E., “Circulation and mixing within Delta flooded−island habitats: Implications for ecosystem restoration”, CALFED Science Conference, January 2003, Sacramento, CA. Schraga, T.S., L.V. Lucas, J.E. Cloern, C.B. Lopez, “Strong diel patterns of phytoplankton biomasss in a tidal flooded island: high frequency and “fast biology”, CALFED

Science Conference, January 2003, Sacramento, CA. Stacey, M.T., D.M. Sereno, S. Baek, and J.R. Burau, “Spatial and seasonal variability in the hydrodynamics of shallow water habitats in the Sacramento−San Joaquin Delta”, CALFED Science Conference, January 2003, Sacramento, CA. Stewart, A.R., M. Doblin, L. Grimaldo, S. Luoma, L. Lucas, “Understanding selenium bioaccumulation in shallow−water habitats of the Sacramento/San Joaquin Delta: Importance of trophic pathways, biogeochemistry and hydrodynamics”, CALFED Science Conference, January 2003, Sacramento, CA. Thompson, J.K., F. Parchaso, M. Shouse, H. Peterson, “The distribution and temporal trends in Corbicula fluminea biomass and what they tell us about the function of habitats”, CALFED Science Conference, January 2003, Sacramento, CA. Baines, S.B., N.S. Fisher, L.S. Cutter, M.A. Doblin, G.A. Cutter, “Direct uptake of dissolved organic selenium by riverine phytoplankton inferred from selenite:C uptake ratios and Se:C in suspended particles”, American Society of Limnology and Oceanography, February, 2003, Salt Lake City, UT. Cutter, G.A., L.S. Cutter, M.A. Doblin, “Dissolved organic selenide cycling in contrasting ecosystems: open ocean versus tidal freshwaters”, American Society of Limnology and Oceanography, February, 2003, Salt Lake City, UT. Lucas, L.V., “Unraveling variability and revealing uncertainty: a role for science in ecosystem restoration”, CALFED−ERP Brown−bag seminar, March 2003, Sacramento, CA. Sereno, D.M., M.T. Stacey, “Circulation and exchange in shallow, subtidal habitats of the Sacramento−San Joaquin Delta”, 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA. Lucas, L.V., “High frequency periodic physical processes can have long−term effects on water quality”, 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA. Monsen, N.E., “Transport time scales: what do they really mean?”, 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA. Lopez, C.B., L.V. Lucas, J.E. Cloern, T.S. Schraga, “Spatial variability of phytoplankton dynamics in a tidal flooded island”, 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA. Schraga, T.S., C.B. Lopez, L.V. Lucas, J.E. Cloern, “Strong diel patterns of phytoplankton biomass in a tidal lake: high frequency and “fast biology”, 17th Biennial Conference of the Estuarine Research Federation, September 2003, Seattle, WA (poster). Lucas, L.V., “Unraveling variability and revealing uncertainty: a role for science in ecosystem restoration”, California State University, Hayward, Geology seminar, October 2003, Hayward, CA. Lucas, L.V., J.E. Cloern, J.K. Thompson, “Science and Ecosystem Restoration”, Sixth Biennial State of the Estuary Conference, October 2003, San Francisco, CA (poster). Schraga, T.S., C.B. Lopez, L.V. Lucas, J.E. Cloern, “Strong diel patterns of phytoplankton biomass in a tidal lake: high frequency and ‘fast biology’”, Sixth Biennial State of the Estuary Conference, October 2003, San Francisco, CA (poster). Doblin, M.A., L.S. Cutter, G.A. Cutter, “Nutrient and selenium dynamics in a shallow water system”, ASLO/TOS Ocean Research Conference, February 2004, Honolulu HI. Lopez, C.B., T.S. Schraga, A.J. Little, J.E. Cloern, L.V. Lucas, J.J. Orsi, “Ecological values of shallow water habitat in the Delta”, USGS−WRD Seminar, September 2004, Menlo Park, CA. Brown, C.L., S.N. Luoma, “Spatial and temporal distribution of copper in the bioindicator clam, Corbicula fluminea, in the Delta”, CALFED Science Conference, October 2004, Sacramento, CA. Lopez, C.B., T.S. Schraga, A.J. Little, J.E. Cloern, L.V. Lucas, J.J. Orsi, “Ecological values of shallow water habitat in the Delta”, CALFED Science Conference, October 2004, Sacramento, CA. Parchaso, F., J. Thompson, “Distribution and grazing potential of Corbicula fluminea in the Sacramento−San Joaquin Delta”, CALFED Science Conference, October 2004, Sacramento, CA. Sereno, D.M., M.T. Stacey, “The influence of submerged aquatic vegetation on the hydrodynamics in Franks Tract – Observations and Modeling”, CALFED Science Conference, October 2004, Sacramento, CA.

−− Title: Evaluation Of Mercury Transformations And Trophic Transfer In The San Francisco Bay/Delta: Identifying Critical Processes For The Ecosystem Restoration Program Dates: 1 July 2003 – 30 June 2006 Lead Investigator(s): Mark Marvin−DiPasquale (USGS), Robin Stewart (USGS), Nick Fisher (SUNY), and Robert Mason (Univ. of Maryland) Funding Agency/Mechanism: CALFED Bay Delta Environmental Enhancement Act, funding through GCAP Inc. Contract Number: ERP−02 P40 Status: In progress. We are one year into our project and have completed two field trips and most of the analyses associated with samples collected during the field trips. The PIs on the −−−−−−−−−−−−−−−− proposals met in December 2004 in New York to review results obtained so far and to refine future field trips and research needs. The next field trip is scheduled for March 14th, 2005.

Products: Articles in Scientific Journals: None yet.

Presentations: M.C. Marvin−DiPaquale, “Mercury cycling concepts important in the adaptive management of wetland restoration projects”. Calfed Science Conference 2004. M. Stepanova, “Uptake and retention of aqueous and dietary inorganic and methylmercury in two fish species”. SETAC, Portland, OR. 2004.

−− Project Title Sedimentation in the Delta and Suisun Bay Calfed Contract Management Agency CALFED ERP (Donna Podger) Amount Funded $1,367,684 Date Awarded 2001−01−01(continuation of project begun in 1997) Lead Institution U.S. Geological Survey Project Number 01−C06 Status: This Project describes the movement of sediment affecting habitats and the availability of sediment needed for habitat restoration. To assure that project managers and engineers have reliable data and adequate knowledge on the seasonal trends in sediment delivery and on the hydrodynamics of sediment movement in Delta channels, both the system−wide transport of sediment and the local pathways of sedimentation are monitored. With the data collected by this project, we have greatly improved our conceptual model of sediment transport in the Delta and we have developed a sediment budget for the Delta. Data collection and analysis are continuing Products:

Buchanan, P.A., and Ganju, N.K., 2002, Summary of suspended−sediment concentration data, San Francisco Bay, California, water year 2000: U.S. Geological Survey Open File Report 02−146. URL http://water.usgs.gov/pubs/of/ofr02146/

Buchanan, P.A., and Ganju, N.K., 2003, Summary of suspended−sediment concentration data, San Francisco Bay, California, water year 2001: U.S. Geological Survey Open−File Report 03−312. URL http://water.usgs.gov/pubs/of/2003/ofr03312/index/index.htm

Buchanan, P.A., and Ganju, N.K., 2004. Summary of suspended−sediment concentration data, San Francisco Bay, California, Water Year 2002: U.S. Geological Survey Open File Report 2004−1219. http://pubs.water.usgs.gov/ofr2004−1219/

Buchanan, P.A., and Ganju, N.K., in review, Summary of suspended−sediment concentration data in San Francisco Bay, California, water year 2003: USGS Open File Report.

Buchanan, P.A., and Ruhl, C.A., 2000, Summary of suspended−solids concentration data, San Francisco Bay, California, water year 1998: U.S.

Geological Survey Open File Report 00−88, 41 p.

Buchanan, P.A., and Ruhl, C.A., 2001, Summary of suspended−sediment concentration data, San Francisco Bay, California, water year 1999: U.S. Geological Survey Open File Report 01−100, 56 p. URL http://water.usgs.gov/pubs/ofr/ofr01−100/

Burau, J.R., Cuetara, J.I., Ruhl, C.A., Dinehart, R.L., and George, J.E., 2003, Effects of the tides, geometry, meteorology, and project operations on circulation and mixing in a flooded island environment: Lessons from Mildred Island: Proceedings of the 2003 CALFED Science Conference, Sacramento, California, January 14−16, 2003, p. 20.

Cuetara, J.I., Burau, J.R., Ruhl, C.A., Simpson, M.R., Dinehart, R.L., and George, J.E., 2003, Hydrodynamic field investigation on the San Joaquin River near the head of Old River barrier: Proceedings of the 2003 CALFED Science Conference, Sacramento, California, January 14−16, 2003, p. 35.

Dinehart, R.L., 2000, Bedform movement near Threemile Slough near San Joaquin River: Proceedings of the CALFED Science Conference, Sacramento, California, October 3−5, 2000, p. 52.

Dinehart, R.L., 2001, Bedform mapping in the Sacramento River: Proceedings of the Seventh Federal Interagency Sedimentation Conference, Reno Nevada, March 25−29, 2001, p. III−55 − III−62.

Dinehart, R.L., 2002, Bedform movement recorded by sequential single−beam surveys in tidal rivers: Journal of Hydrology, v. 258, p. 25−39.

Dinehart, R.L., 2003, Spatial analysis of ADCP data in streams: Proceedings of the Sediment Monitoring Instrument and Analysis Research Workshop, Flagstaff Arizona, September 9−11, 2003. URL http://water.usgs.gov/osw/techniques/sediment/sedsurrogate2003workshop/dinehart.pdf

Dinehart, R.L., and Burau, J.R., 2003, Repeated surveys by Acoustic Doppler Current Profiler for flow and sediment dynamics at Delta Cross Channel: Proceedings of the 2003 CALFED Science Conference, Sacramento, California, January 14−16, 2003, p. 43.

Dinehart, R.L., and Schoellhamer, D.H., 1999, Sedimentation in the Delta of the Sacramento and San Joaquin Rivers: Proceedings of the 4th biennial State of the Estuary Conference, San Fran−cisco, Calif., March 17−19, 1999, p. 75. URL http://ca.water.usgs.gov/program/sfbay/calfedsed/estuary_99_abs.html

McKee, L., Ganju, N.K., and Schoellhamer, D.H., Estimates of suspended sediment entering San Francisco Bay from the Sacramento and San Joaquin Delta, San Francisco Bay, California: submitted to Journal of Hydrology.

McKee, L., Ganju, N., Schoellhamer, D., Davis, J., Yee, D., Leatherbarrow, J., and Hoenicke, R., 2002, Estimates of suspended sediment flux entering San Francisco Bay from the Sacramento and San Joaquin Delta: Report prepared for the Sources Pathways and Loading Workgroup of Regional Monitoring Program for Trace Substances in the San Francisco Estuary, San Francisco Estuary Institute, Oakland, California, 28 p. http://www.sfei.org/watersheds/reports/Delta_sediment_loads/MallardIssedimentloads.pdf

Oltmann, R.N., Schoellhamer, D.H., and Dinehart, R.L., 1999, Sediment inflow to the Sacra−mento−San Joaquin Delta and the San Francisco Bay: Interagency Ecological Program newsletter, v. 12, no. 1, pp. 30−33

Ruhl, C.A., and Schoellhamer, D.H., 2000, Spatial and seasonal variability of suspended−sediment concentrations in Honker Bay, a shallow subembayment of San Francisco Bay: Proceedings of the CALFED Science Conference, Sacramento, California, October 3−5, 2000, p. 218.

Ruhl, C.A., and Schoellhamer, D.H., 2004, Spatial and Temporal Variability of Suspended−Sediment Concentrations in a Shallow Estuarine Environment: San Francisco Estuary and Watershed Science. v. 2, no. 2, article 1. http://repositories.cdlib.org/jmie/sfews/vol2/iss2/art1

Schoellhamer, D.H., 2001, Continiuous monitoring of suspended sediment in rivers by use of optical sensors: Proceedings of the Seventh Federal Interagency Sedimentation Conference, Reno Nevada, March 25−29, 2001, p. III−160 − III−167. http://ca.water.usgs.gov/abstract/sfbay/Schoellhamer.pdf

Schoellhamer, D.H., Buchanan, P.A., and Ganju, N.K., 2002, Ten years of continuous suspended−sediment concentration monitoring in San Francisco Bay and Delta: Proceedings of the Turbidity and Other Sediment Surrogates Workshop, Reno, Nevada, April 30 − May 2, 2002. URL http://water.usgs.gov/osw/techniques/TSS/schoelhamer.pdf

Schoellhamer, D.H., and Dinehart, R.L., 2000, Suspended−sediment supply to the Delta from the Sacramento River: Proceedings of the CALFED Science Conference, Sacramento, California, October 3−5, 2000, p. 124. URL http://ca.water.usgs.gov/program/sfbay/calfedsed/SedimentSupply.html

Schoellhamer, D.H., Shellenbarger, G.G., Ganju, N.K., Davis, J.A., and McKee, L.J., 2003, Sediment dynamics drive contaminant dynamics: The Pulse of the Estuary: Monitoring and Managing Contamination in the San Francisco Estuary, San Francisco Estuary Institute, Oakland, California, p. 21−26. http://www.sfei.org/rmp/pulse/pulse2003.pdf

Schoellhamer, D.H., and Wright, S.A., 2002, Continiuous monitoring of suspended sediment in rivers by use of optical backscatterance sensors: Proceedings of the IAHS workshop on Erosion and sediment transport measurement: Technological and Methodological advances, Oslo, Norway, June 19−21, 2002. URL http://www.nve.no/iahs_ws_oslo2002/4Schoellhamer_Wright.pdf

Schoellhamer, D.H., and Wright, S.A., 2003, Continuous monitoring of suspended sediment discharge in rivers by use of optical backscatterance sensors,

in Bogen, J., Fergus, T., and Walling, D.E., ed., Erosion and Sediment Transport Measurement: Technological and Methodological Advances: International Association for Hydrological Science Publication 283, p. 28−36. http://www.cig.ensmp.fr/~iahs/redbooks/a283/28304.htm

Warner, J.C., Schoellhamer, D.H., Ruhl, C.A., and Burau, J.R., 2004, Floodtide pulses after low tides in shallow subembayments adjacent to deep channels: Estuarine, Coastal and Shelf Science, v. 60, no. 2, p. 213−228.

Wright, S.A., 2003, Comparison of direct and indirect measurements of cohesive sediment concentration and size: Proceedings of the Sediment Monitoring Instrument and Analysis Research Workshop, Flagstaff Arizona, September 9−11, 2003. URL:http://water.usgs.gov/osw/techniques/sediment/sedsurrogate2003workshop/wright.pdf

Wright, S.A. and Schoellhamer, D.H., 2003, Trends in the sediment yield of the Sacramento River, 1957−2001: Proceedings of the 2003 CALFED Science Conference, Sacramento, California, January 14−16, 2003, p. 177. http://ca.water.usgs.gov/abstract/sfbay/abstractsedimentyield2003.html

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Wright, S.A., and Schoellhamer, D.H., 2004b, Suspended sediment transport where rivers become estuaries: Sacramento – San Joaquin River Delta, water years 1999−2002: Proceedings of the 2004 CALFED Science Conference, Sacramento, California, October 4−6, 2004, p. 237. http://cain.nbii.gov/regional/calfed/calfedabstracts

Wright, S.A., and Schoellhamer, D.H., Suspended sediment transport where rivers become estuaries: Sacramento – San Joaquin River Delta, water years 1999−2002: submitted to Water Resources Research.

−− Project Title Dissolved Organic Carbon Release from Delta Wetlands: Amounts, Alterations, and Implications for Drinking Water Quality and the Delta Foodweb. Part 2 − Fluxes and Loads from Tidal and Non−Tidal Wetlands and from Agricultural Operations Calfed Program Ecosystem Restoration Calfed Contract Management Agency U.S. Bureau of Reclamation Amount Funded $2,740,040 (total for multi PI, multi institutional proposal) Date Awarded 2000−01−01 Project Number 2000−G01 Status: Schoellhamer and Ganju's contribution to this large project is to collaborate on collection and analysis of water discharge, sediment, and carbon data at Browns Island, a tidal wetland in the Delta. Data collection and analysis is continuing. Products:

Bergamaschi, B.A., Downing, B.D., Wheeler, G.A., Schoellhamer, D.H., Ganju, N., Fram, M.S., Erickson, D.E., Kendall, C., Bemis, B.E., Stepanauskas, R., Hollibaugh, J.T., and Fujii, R., 2003, Quantifying the contributions of tidal wetlands to dissolved organic material in the San Francisco Estuary, California, USA: Proceedings of the 17th Biennial Conference of the Estuarine Research Federation, Seattle, Washington, September 14−18, 2003, p. 13. https://www.sgmeet.com/erf/erf2003/viewabstract.asp?AbstractID=4894=48

Downing, B., Wheeler, G., Emerson, S., Ganju, N., and Bergamaschi, B., 2003, Continuous, real−time optical measurement of DOC fluxes in a tidal wetland: Proceedings of the 6th biennial State−of−the−Estuary Conference, Oakland, California, October 21−23, 2003, p. 73.

Fujii. R., Bergamaschi, B.A., Ganju, N.K., Fleck, J.A., Burow− Fogg, K.R., Schoellhamer, D., Deverel, S.J., 2003, Preliminary Assessment of DOC and THM Precursor Loads from a Freshwater Restored Wetland, an Agricultural Field, and a Tidal Wetland in the Sacramento−San Joaquin River Delta: Proceedings of the 2003 CALFED Science Conference, Sacramento, California, January 14−16, 2003, p. 206. http://ca.water.usgs.gov/abstract/sfbay/abstractdoc2003.html

Ganju, N.K., Bergamaschi, B., and Schoellhamer, D.H., 2003, Tidal wetland fluxes of dissolved organic carbon and sediment at Browns Island, California: Initial evaluation: Proceedings of the 2003 CALFED Science Conference, Sacramento, California, January 14−16, 2003, p. 208. http://ca.water.usgs.gov/abstract/sfbay/abstractwetlandflux2003.html

Ganju, N.K., Bergamaschi, B., and Schoellhamer, D.H., Measurement of water, sediment, and carbon fluxes from a tidal wetland: submitted to Estuaries.

Lionberger, M.A., Ganju, N.K., Schoellhamer, D.H., Downing, B.D., Bergamaschi, B.A., and Wheeler, G.A., Wetland fluxes of dissolved organic carbon and sediment at Browns Island, California: balancing the water budget: abstract for the 2004 CALFED Science Conference.

All applicants must identify all sources of funding other than the funds requested through this solicitation to support the effort outlined in their proposal. Applicants must include the status of these commitments (tentative, approved, received), the source, and any cost−sharing requirements. Successful proposals that demonstrate multiple sources of funding must have the commitment of the non−Science Program PSP related funding within 30 days of notification of approval of Science Program PSP funds. If an applicant fails to secure the non−Science Program PSP funds identified in the proposal, and as a result has insufficient funds to complete the project, CBDA retains the option to amend or terminate the award. The California Bay−Delta Authority reserves the right to audit grantees.

Status	**Proposal Title**	**Funding Source**	**Period Of Commitment**	**Requirements And Comments**

Are you specifically seeking non−federal cost−share funds for this proposal?
No.

In addition to the general funds available, are you targeting additional funds set aside specifically for collaborative proposals?
No.

List people you feel are qualified to act as scientific reviewers for this proposal and are not associated with CALFED.

Full Name	Organization	Telephone	E−Mail	Expertise
Dr. Donald F. Boesch, President	***University of MarylandCenter for Environmental Studies***	***410−228−9250***	***boesch@ca.umces.edu***	***natural resource management***
Dr. Anne E. Giblin	***Ecosystems Center Woods Hole Marine Biological Laboratory***	***508−289−7488***	***agiblin@mbl.edu***	***climate, climate change***
Dr. Scott W. Nixon	***Oceanography University of Rhode Island***	***401−874−6800***	***swn@gso.uri.edu***	***modeling, quantitative***
Dr. Andrew W. Wood	***Department of Civil and Environmental Engineering University of Washington***	***206 685 1796***	***aww@hydro.washington.edu***	***engineering, environmental***

Executive Summary

Provide a brief but complete summary description of the proposed project; its geographic location; project objective; approach to implement the proposal; hypotheses being tested; expected outcomes; and relationship to Science Program priorities. The Executive Summary should be a concise, informative, stand−alone description of the proposed project. *(This information will be made public on our website shortly after the closing date of this PSP.)*

Agencies of the CALFED Bay−Delta Authority (CBDA) face tough decisions as they search for strategies to meet their programmatic goals of stabilizing water supplies in California, providing safe drinking water to a growing population, and sustaining diverse populations of native species and their supporting ecosystem functions. The challenge of finding balanced solutions to these goals is daunting because of the enormous complexity of the San Francisco Bay−Delta system and its tributary rivers and their watersheds. The challenge grows as we consider the additional layer of complexity imposed by the certainty that all the key forces that drive dynamics of this ecosystem (climate, hydrology, water management, land use, sea level) will change significantly in future decades. This proposal describes a model−based approach for developing a long view of the Bay−Delta−River−Watershed system. The long view will be developed through simulations with linked models to project changes under a range of plausible scenarios of global warming, hydrologic responses, land−use change, reconfigurations of within−Delta habitats, and sea level rise. Scenarios were selected to provide robust and plausible future visions motivated by the following kinds of questions: How might global warming alter California's precipitation, streamflow and flood frequency in the 21st century? Will continued rise of sea level or catastrophic levee failure move salt into the Delta and require additional releases of impounded water to meet drinking water standards? How will new storage and conveyance structures alter water flow across the Delta? Will altered streamflow, temperature and transports influence production of juvenile salmon, spawning of Delta smelt, or other processes regulating species of concern? Will alien species exploit new habitats, disrupt foodwebs that sustain native species, or alter the movement of toxic elements into foodwebs? Will system productivity increase or decrease? Will sediment retention in reservoirs limit our capacity to build new habitats or change the sediment supply and geomorphology of San Francisco Bay? How might all these changes interact to constrain CBDA success at meeting its goals? Can we anticipate and adapt management strategies to these system changes before they occur? Our goals are to develop and apply a model−based approach of ecological forecasting to project future states of the Delta ecosystem under prescribed scenarios of change, and to communicate the outcomes of those scenarios to resource managers facing the daunting challenge of meeting CBDP goals in a continually changing world.

Give additional comments, information, etc. here.

Total cost of this 3−year project is $3.48M, of which $1.64M (47%) will be provided by the U.S. Geological Survey, primarily through its Priority Ecosystems Program. Most of the request to CALFED will support salary of personnel in nonpermannent positions, primarily postdoctoral associates to perform research tasks in collaboration with USGS mentors.

Applicant

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004−12−27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

Instructions

Information provided on this form will automatically support subsequent forms to be completed as part of the Science PSP submission process. Please be mindful of what information you enter and how it may be represented in the Personnel, Task and Budget forms. Please provide this information before continuing to those forms.

All information on this page is to be provided for the agency or institution to whom funds for this proposal would be awarded.

Applicant Institution	***United States Geological Survey***	*This list comes from the project form.*
Applicant_institution Type	***federal agency***	

Institution Contact

Please provide information for the primary person responsible for oversight of grant operation, management, and reporting requirements.

Salutation	
First Name	***James***
Last Name	***Cloern***
Street Address	***USGSMS496, 345 Middlefield Rd.***
City	***Menlo Park***
State Or Province	***Ca***
ZIP Code Or Mailing Code	***94025***
Telephone	***6503294594*** *Include area code.*
E−Mail	***jecloern@usgs.gov***

Additional information regarding prior applications submitted to CALFED by the applicant organization or agency and/or funds received from CALFED programs by applicant organization or agency may be required.

Personnel

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004−12−27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

Instructions

Applicants must provide brief biographical sketches, titles, affiliations, and descriptions of roles, relevant to this effort, of the principal and supporting project participants by completing a Personnel Form. This includes the use of any consultants, subcontractors and/or vendors; provide information on this form for all such people.

Information provided on this form will automatically support subsequent forms to be completed as part of the Science PSP submission process. Please be mindful of what information you enter and how it may be represented in the Task and Budget forms.

Information regarding anticipated subcontractor services must be provided regardless if the specific service provider has been selected or not. If the specific subcontractor has not been identified or selected, please list TBD (to be determined) in the Full Name field and the anticipated service type in the Title field (example: Hydrology Expert).

Please provide this information before continuing to those forms.

Cloern, James E., PhD.

*This person is the **Lead Investigator**. Contact information for this person is required.*

Full Name	***Cloern, James E., PhD.***	example: Wright, Jeffrey R., PhD.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Senior Research Biologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Project oversight, coordination, and overall responsibility for deliverables.	
Qualifications		*You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*
Mailing Address	***USGSMS496, 345 Middlefield Rd.***	
City	***Menlo Park***	
State	***CA***	
ZIP	***94025***	
Business Phone	***6503294594***	
Mobile Phone	***6503035217***	
E−Mail	***jecloern@usgs.gov***	

Describe other staff below. If you run out of spaces, submit your updates and return to this form.

Brown, Larry R., PhD.

Full Name	***Brown, Larry R., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Biologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 7 Lead Scientist: assess population responses of native and alien fishes to habitat changes projected by Tasks 1−6.	

Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Lucas, Lisa L., PhD.

Full Name	***Lucas, Lisa L., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Environmental Engineer***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 3 Principal Investigator: assess changes in phytoplankton biomass and primary production in the Delta, using inputs from Tasks 1−4.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Monsen, Nancy E., PhD.

Full Name	***Monsen, Nancy E., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Physical Scientist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 3 Principal Investigator; assess changes in Delta hydrodynamics, including flow paths and water residence time and source mixtures, using inputs from Tasks 1−2 and the model DELTATRIM.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Dettinger, Michael D., PhD.

Full Name	***Dettinger, Michael D., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Hydrologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 1 &2 Principal Investigator: downscale projections from GCM's to assess regional−scale changes in climate at the scale of the Bay−Delta watershed.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Cayan, Daniel R., PhD.

Full Name	***Cayan, Daniel R., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***Scripps Institute of Oceanography***	*This list comes from the project form.*
Title	***Director, Climate Research Division, Scripps Institute of Oceanography***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 1 &2 Principal Investigator: downscale projections from GCM's to assess regional−scale changes in climate at the scale of the Bay−Delta watershed.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Ganju, Neil K., PhD.

Full Name	***Ganju, Neil K., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Hydraulic Engineer***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 4 Principal Investigator: assess changes in sediment supply to and transport within the Bay−Delta, using inputs from Tasks 1−2.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Peterson, David H., PhD.

Full Name	***Peterson, David H., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Oceanographer***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 1 &2 Principal Investigator: downscale projections from GCM's to assess regional−scale changes in climate at the scale of the Bay−Delta watershed.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Thompson, Janet K., PhD.

Full Name	***Thompson, Janet K., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution		*This list comes from the project form.*

	United States Geological Survey	
Title	***Environmental Engineer and Marine Ecologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 6 Principal Investigator: assessment of potential habitat expansion of three key alien species in the Delta, using inputs from Tasks 1−5.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Schoellhamer, David, PhD.

Full Name	***Schoellhamer, David, PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Hydrologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 4 Principal Investigator: assess changes in sediment supply to and transport within the Bay−Delta, using inputs from Tasks 1−2.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Knowles, Noah, PhD.

Full Name	***Knowles, Noah, PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Hydrologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 1 &2 Principal Investigator: assess changes in water and sediment runoff and streamflow to the Delta, changes in river temperature, and changes in salinity and temperature in the Bay−Delta using inputs from Task 1.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Jaffe, Bruce., PhD.

Full Name	***Jaffe, Bruce., PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Oceanographer***	*example: Dean of Engineering*
Position Classification	***primary staff***	

Responsibilities	Task 4 Principal Investigator: assess changes in sediment loadings and the geomorphology of the Delta and Bay, using inputs from Tasks 1 and 2.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Stewart, A. Robin, PhD.

Full Name	***Stewart, A. Robin, PhD.***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Research Hydrologist***	*example: Dean of Engineering*
Position Classification	***primary staff***	
Responsibilities	Task 5 Principal Investigator; assess changes in the loadings and bioaccumulation of mercury, selenium, cadmium and silver in the Delta, using inputs from Tasks 1−4.	
Qualifications		***This is only required for primary staff.*** *You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.*

Postdoc Task 5

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Postdoc Task 5***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Task 5 Postdoctoral Associate: assess changes in the loadings and bioaccumulation of mercury, selenium, cadmium and silver in the Delta, using inputs from Tasks 1−4.	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Biologist1 Task 6

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Biologist1 Task 6***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Compilations of physiological data for Corbicula, Potamocorbula	
Qualifications		***This is only required for primary staff.***

		Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.

Biologist 2 Task 6

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Biologist 2 Task 6***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Compilations of physiological data for Egeria	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Postdoc Task 7

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Postdoc Task 7***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Task 7 Postdoctoral Associate: assess population responses of native and alien fishes to habitat changes projected by Tasks 1−6	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Postdoc Task 3

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Postdoc Task 3***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Task 3 Postdoctoral Associate: assess changes in water temperature across the Delta, using inputs from Tasks 1−2.	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Postdoc Task 4

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***United States Geological Survey***	*This list comes from the project form.*
Title	***Postdoc Task 4***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Task 4 Postdoctoral Associate: assess changes in sediment loadings and the geomorphology of the Delta and Bay, using inputs from Tasks 1 and 2.	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Postdoc Task 1

Full Name		example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution	***Scripps Institute of Oceanography***	*This list comes from the project form.*
Title	***Postdoc Task 1***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Task 1 Postdoctoral Associate: downscale projections from GCM's to assess regional−scale changes in climate at the scale of the Bay−Delta watershed.	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Operations Modeler

Full Name	***Operations Modeler***	example: Wright, Jeffrey R., PhD. Leave blank if name not known.
Institution		*This list comes from the project form.*
Title	***Operations Modeler***	*example: Dean of Engineering*
Position Classification	***secondary staff***	
Responsibilities	Tasks 1CALSIM simulations and integration with the watershed modeling.	
Qualifications		***This is only required for primary staff.*** *Upload a PDF version of this person's resume that is no more than five pages long. To upload a resume, use the "Browse" button to select the PDF file containing the resume.*

Conflict Of Interest

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004−12−27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

Instructions

To help Science Program staff manage potential conflicts of interest in the review and selection process, we need some information about who will directly benefit if your proposal is funded. We need to know of individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal, or who will benefit financially if the proposal is funded;
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.

Applicant	United States Geological Survey
Submittor	Cloern, James E
Primary Staff	Cloern, James E., PhD.
Primary Staff	Brown, Larry R., PhD.
Primary Staff	Lucas, Lisa L., PhD.
Primary Staff	Monsen, Nancy E., PhD.
Primary Staff	Dettinger, Michael D., PhD.
Primary Staff	Cayan, Daniel R., PhD.
Primary Staff	Ganju, Neil K., PhD.
Primary Staff	Peterson, David H., PhD.
Primary Staff	Thompson, Janet K., PhD.
Primary Staff	Schoellhamer, David, PhD.
Primary Staff	Knowles, Noah, PhD.
Primary Staff	Jaffe, Bruce., PhD.
Primary Staff	Stewart, A. Robin, PhD.
Secondary Staff	*Postdoc Task 5
Secondary Staff	*Biologist1 Task 6
Secondary Staff	*Biologist 2 Task 6
Secondary Staff	*Postdoc Task 7
Secondary Staff	*Postdoc Task 3
Secondary Staff	*Postdoc Task 4
Secondary Staff	*Postdoc Task 1
Secondary Staff	Operations Modeler

Are there other persons not listed above who helped with proposal development?
No.

If there are, provide below the list of names and organizations of all individuals not listed in the proposal who helped with proposal development along with any comments.

Tasks

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004−12−27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

Instructions

Utilize this Task Table to delineate the tasks identified in your project description. Each task and subtask must have a number, title, brief description of the task (detailed information should be provided in the project description), timeline, list of personnel or subcontractors providing services on each specific task, and list of anticipated deliverables (where appropriate). When creating subtasks, information must be provided in a way that avoids duel presentation of supporting tasks within the overall task (i.e. avoid double counting). Information provided in the Task Table will be used to support the Budget Form. Ensuring information regarding deliverables, personnel and costs associated with subtasks are only provided once is imperative for purposes of avoiding double counting of efforts within the Budget Form.

For proposals involving multiple institutions (including subcontractors), the table must clearly state which institutions are performing which tasks and subtasks.

Task ID	Task Name	Start Month	End Month	Personnel Involved	Description	Deliverables
1	***Climate Modeling***	*1*	*36*	***Dettinger, Michael D., PhD.*** ***Cayan, Daniel R., PhD.*** ***Peterson, David H., PhD.*** ***Knowles, Noah, PhD.*** ****Postdoc Task 1 Operations Modeler***	Use outputs of selected GCM models and Operations Models to develop detailed scenarios of climate change in California through the 21st century.	Daily weather series at 200 stations for the 20th and 21st centuries with concurrent sets of sea temperature and sea level variability and trends.
2	***Watershed−Estuary Modeling***	*1*	*36*	***Dettinger, Michael D., PhD.*** ***Cayan, Daniel R., PhD.*** ***Peterson, David H., PhD.*** ***Knowles, Noah, PhD.***	Apply the watershed model BDWM to compute runoff and inflows to the Delta under scenarios prescribed in Task 1. Apply the model UP to compute currents, salinity and temperature in San Francisco Bay under these scenarios.	Computed salinity and currents in San Francisco Bay, Delta inflows from its tributary rivers, flow rates, saliniities and temperatures in the rivers.
3	***Delta Modeling***	*1*	*36*	***Cloern, James E., PhD.*** ***Lucas, Lisa L., PhD.*** ***Monsen, Nancy E., PhD.*** ****Postdoc Task 3***	Apply the model DeltaTRIM to compute tidal currents/stage, water temperature and phytoplankton biomass and primary production in the Delta under scenarios prescribed in Task1.	Computed tidal current speeds and direction, stage, salinity, source water mixture and residence time in the Delta. Computed water temperature and thermal stratification in the Delta. Computed directional changes in phytoplankton biomass and primary production in the Delta.
4	***Sediment, Geomorphology and Tidal−habitat Modeling***	*1*	*36*	***Ganju, Neil K., PhD.*** ***Schoellhamer, David, PhD.*** ***Jaffe, Bruce., PhD.*** ****Postdoc Task 4***	Construct and link models to compute sediment inputs to the Delta and downstream embayments of San Francisco Bay, patterns of sediment deposition and redistributions, and future geomorphology of San Francisco Bay.	Computed changes in sediment supply and deposition in the Delta and San Francisco Bay. Computed changes in geomorphology of San Francisco Bay including long term changes in habitats.
5						

	Fate and Effects of Se, Hg, Ag and Cd	***1***	***36***	***Stewart, A. Robin, PhD.*** ****Postdoc Task 5***	Project changes in the loadings and bioaccumulation of toxic contaminants in the Delta and San Francisco Bay.	Projected riverine loadings of selenium, mercury, cadmium and silver to the central Delta and Suisun Bay. Projected trends of change in bioaccumulation of these elements within Bay−Delta food webs.
6	***Invasive Species Potamocorbula, Corbicula and Egeria***	***1***	***36***	***Thompson, Janet K., PhD.*** ****Biologist1 Task 6*** ****Biologist 2 Task 6***	Use outputs from Tasks 1−4 to assess the potential spread and population growth of these key alien species in the Delta under prescribed scenarios of future change.	Seasonal estimates of the biomass distribution for Corbicula and Potamocorbula and qualitative distributions of Egeria density throughout Suisun Bay and the Delta.
7	***Native and Alien Fish Population Trends***	***1***	***36***	***Brown, Larry R., PhD.*** ****Postdoc Task 7***	Use outputs from Tasks 1−6 to assess potential population responses of native and alien fishes in the Delta under prescribed scenarios of change.	A suite of simple life cycle models for alien and native fishes in the Delta. Assessments of likely population responses of these species to projected changes in salinity, temperature and flow.
8	***Project Administration***	***1***	***36***	***Cloern, James E., PhD.*** ***Knowles, Noah, PhD.***	Coordinate information exchange between Tasks 1−7. Coordinate product dissemination, budget reporting, and delivery of progress reports.	Progress reports, budget reports, and communications to collaborators and interested stakeholders

Budget

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004−12−27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

Instructions

All applicants must complete a budget for each task and subtask. The Budget Form uses data entered in the Task Form, thus tasks should be entered before starting this form. Failure to complete a Budget Form for each task and/or subtask will result in removal of the application from consideration for funding.

CBDA retains the right to request additional information pertaining to the items, rates, and justification of the information presented in the Budget Form(s).

Supporting details on how costs were derived for each line item must be included in the justification section for each item. The cost detail for each item should include the individual cost calculations associated with each line item to provide the basis for determining the total amount for each budget category.

Following are guidelines for completing the justification section of this form:

Labor (Salary &Wages)

Ensure each employee and associated classification is correctly identified for each task and subtask. This information will automatically be provided once the Staff Form has been completed. Provide estimated hours and hourly rate of compensation for each position proposed in the project.

Employee Benefits

Benefits, calculated as a percentage of salaries, are contributions made by the applicant for sick leave, retirement, insurance, etc. Provide the overall benefit rate and specify benefits included in this rate for each employee classification proposed in the project.

Travel

Travel includes the cost of transportation, subsistence, and other associated costs incurred by personnel during the term of the project. Provide purpose and estimated costs for all travel. Reoccurring travel costs for a particular task or subtask may be combined into one entry. The number of trips and cost for each occurrence must be clearly represented in the justification section for reoccurring travel items of this nature.

Any reimbursement for necessary travel and per diem shall be at rates specified by the California Department of Personnel Administration for similar employees (www.dpa.ca.gov/jobinfo/statetravel.shtm).

Equipment

Equipment is classified as any item of $5,000 or more and has an expected life of three years or more. Equipment purchased in whole or in part with these grant funds must be itemized. List each piece of equipment and provide a brief description and justification for each.

Supplies

Provide a basic description and cost for expendable research supplies. Costs associated with GIS services, air photos, reports, etc. must be listed separately and have a clear justification associated with each entry. Postage, copying, phone, fax and other basic operational costs associated with each task and subtask may be combined unless the cost associated with one particular service is unusually excessive.

Subcontractor Services

Subcontractor services (Professional and Consultant services) include the total costs for any services needed by the applicant to complete the project tasks. Ensure the correct organization is entered in the Personnel Form so that it appropriately appears on the Budget Form. The applicant must provide all associated costs of all subcontractors (i.e. outside service providers) when completing this form. Applicants must be able to demonstrate that all subcontractors were selected according to an applicant's institutional requirements for the selection of subcontractors (competitive selection or sole source justification).

CBDA retains the right to request that a subcontractor provide cost estimates in writing prior to distribution of grant funds.

CBDA retains the right to request consultant, subcontractor, and/or outside service provider cost estimates in writing prior to distribution of grant funds.

Indirect Costs (Overhead)

Indirect costs are overhead expenses incurred by the applicant organization as a result of the project but are not easily identifiable with a specific project. The indirect cost rate consists of a reasonable percentage of all costs to run the agency or organization while completing the project. List the cost and items associated with indirect costs. (These items may include general office expenses such as rent, office equipment, administrative staff, operational costs, etc. Generally these items are represented by the applicant through a predetermined percentage or surcharge separate from other specific costs of items necessary to complete a specific task or subtask.)

If indirect cost rates are different for State and Federal funds, please identify each rate and the specific items included in the calculation for that rate.

Task 1, Climate Modeling: Labor	Justification	Amount

Dettinger, Michael D., PhD.	***Dettinger salary provided by USGS***	***0***
Cayan, Daniel R., PhD.	***Cayan salary provided by USGS***	***0***
Peterson, David H., PhD.	***Peterson salary provided by USGS***	***0***
Knowles, Noah, PhD.	***Knowles salary in Task 2***	
***Postdoc Task 1**		***103871***
Operations Modeler		***36747***
Task 1, Climate Modeling: Benefits	**Justification**	**Amount**
Dettinger, Michael D., PhD.	***Dettinger salary provided by USGS***	***0***
Cayan, Daniel R., PhD.	***Cayan salary provided by USGS***	***0***
Peterson, David H., PhD.	***Peterson salary provided by USGS***	***0***
Knowles, Noah, PhD.	***Knowles salary in Task 2***	
***Postdoc Task 1**		***31161***
Operations Modeler		***11024***
Task 1, Climate Modeling: Travel Expenses	**Justification**	**Amount**
Task 1, Climate Modeling: Supplies And Expendables	**Justification**	**Amount**
Task 1, Climate Modeling: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 1, Climate Modeling: Equipment	**Justification**	**Amount**
Task 1, Climate Modeling: Other Direct	**Justification**	**Amount**
Task 1, Climate Modeling: Indirect (Overhead)	**Justification**	**Amount**
		104203
	Task 1 Total	$287,006
Task 2, Watershed−Estuary Modeling: Labor	**Justification**	**Amount**
Dettinger, Michael D., PhD.	***Dettinger salary provided by USGS***	***0***
Cayan, Daniel R., PhD.	***Cayan salary provided by USGS***	***0***
Peterson, David H., PhD.	***Peterson salary provided by USGS***	***0***
Knowles, Noah, PhD.		***200651***
Task 2, Watershed−Estuary Modeling: Benefits	**Justification**	**Amount**
Dettinger, Michael D., PhD.	***Dettinger salary provided by USGS***	***0***
Cayan, Daniel R., PhD.	***Cayan salary provided by USGS***	***0***
Peterson, David H., PhD.	***Peterson salary provided by USGS***	***0***
Knowles, Noah, PhD.		***44144***
Task 2, Watershed−Estuary Modeling: Travel Expenses	**Justification**	**Amount**
Task 2, Watershed−Estuary Modeling: Supplies And Expendables	**Justification**	**Amount**
Task 2, Watershed−Estuary Modeling: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 2, Watershed−Estuary Modeling: Equipment	**Justification**	**Amount**
Task 2, Watershed−Estuary Modeling: Other Direct	**Justification**	**Amount**
Task 2, Watershed−Estuary Modeling: Indirect (Overhead)	**Justification**	**Amount**
		139533
	Task 2 Total	$384,328
Task 3, Delta Modeling: Labor	**Justification**	**Amount**
Cloern, James E., PhD.	***Cloern salary provided by USGS***	***0***

Lucas, Lisa L., PhD.	***Lucas salary provided by USGS***	***0***
Monsen, Nancy E., PhD.		***132162***
***Postdoc Task 3**		
Task 3, Delta Modeling: Benefits	**Justification**	**Amount**
Cloern, James E., PhD.	***Cloern salary provided by USGS***	***0***
Lucas, Lisa L., PhD.	***Lucas salary provided by USGS***	
Monsen, Nancy E., PhD.		***29074***
***Postdoc Task 3**		
Task 3, Delta Modeling: Travel Expenses	**Justification**	**Amount**
Conferences	***Travel for presentations of results at conferences***	***4000***
Other	***Scientific illustrations***	***2000***
Task 3, Delta Modeling: Supplies And Expendables	**Justification**	**Amount**
Task 3, Delta Modeling: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 3, Delta Modeling: Equipment	**Justification**	**Amount**
	PC to run DeltaTrim model	***3000***
Task 3, Delta Modeling: Other Direct	**Justification**	**Amount**
Task 3, Delta Modeling: Indirect (Overhead)	**Justification**	**Amount**
		98737
	Task 3 Total	$268,973
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Labor	**Justification**	**Amount**
Ganju, Neil K., PhD.		***57564***
Schoellhamer, David, PhD.		***28536***
Jaffe, Bruce., PhD.	***Jaffe salary provided by USGS***	***0***
***Postdoc Task 4**		***53643***
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Benefits	**Justification**	**Amount**
Ganju, Neil K., PhD.		***14391***
Schoellhamer, David, PhD.		***7134***
Jaffe, Bruce., PhD.	***Jaffe salary provided by USGS***	***0***
***Postdoc Task 4**		***11801***
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Travel Expenses	**Justification**	**Amount**
Other	***Travel for Jaffe field work and pesentation of results before meetings of scientific societies, CALFED Science Conference, State of the Estuary Conference***	***6000***
Other	***Travel for Schoellhamer group***	***6360***
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Supplies And Expendables	**Justification**	**Amount**
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Equipment	**Justification**	**Amount**
PC	***Personal computer to run ROMS model***	***6000***
	software	***3600***

Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Other Direct	**Justification**	**Amount**
Task 4, Sediment, Geomorphology And Tidal−Habitat Modeling: Indirect (Overhead)	**Justification**	**Amount**
		162547
	Task 4 Total	$357,576
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Labor	**Justification**	**Amount**
Stewart, A. Robin, PhD.	***Stewart salary provided by USGS***	***0***
***Postdoc Task 5**		***42479***
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Benefits	**Justification**	**Amount**
Stewart, A. Robin, PhD.	***Stewart salary provided by USGS***	***0***
***Postdoc Task 5**		***12743***
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Travel Expenses	**Justification**	**Amount**
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Supplies And Expendables	**Justification**	**Amount**
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Equipment	**Justification**	**Amount**
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Other Direct	**Justification**	**Amount**
Task 5, Fate And Effects Of Se, Hg, Ag And Cd: Indirect (Overhead)	**Justification**	**Amount**
		31478
	Task 5 Total	$86,700
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Labor	**Justification**	**Amount**
Thompson, Janet K., PhD.	***Thompson salary provided by USGS***	***0***
***Biologist1 Task 6**		***16261***
***Biologist 2 Task 6**		***15204***
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Benefits	**Justification**	**Amount**
Thompson, Janet K., PhD.	***Thompson salary provided by USGS***	***0***
***Biologist1 Task 6**		***6969***
***Biologist 2 Task 6**		***6516***
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Travel Expenses	**Justification**	**Amount**
Conferences	***Travel for presentations of results at conferences***	***3000***
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Supplies And Expendables	**Justification**	**Amount**
Office/Presentation Supplies	***Miscellaneous supplies***	***1500***
	STELLA software	***2500***
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Subcontractors	**Justification**	**Amount**

No subcontractor was assigned to this task.		
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Equipment	**Justification**	**Amount**
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Other Direct	**Justification**	**Amount**
Task 6, Invasive Species Potamocorbula, Corbicula And Egeria: Indirect (Overhead)	**Justification**	**Amount**
		29612
	Task 6 Total	$81,562
Task 7, Native And Alien Fish Population Trends: Labor	**Justification**	**Amount**
Brown, Larry R., PhD.		***50682***
***Postdoc Task 7**		***50585***
Task 7, Native And Alien Fish Population Trends: Benefits	**Justification**	**Amount**
Brown, Larry R., PhD.		***11114***
***Postdoc Task 7**		***11129***
Task 7, Native And Alien Fish Population Trends: Travel Expenses	**Justification**	**Amount**
Conferences	***Travel for presentations of results at conferences***	***4450***
Task 7, Native And Alien Fish Population Trends: Supplies And Expendables	**Justification**	**Amount**
Office/Presentation Supplies	***Miscellaneous supplies***	***1650***
Task 7, Native And Alien Fish Population Trends: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 7, Native And Alien Fish Population Trends: Equipment	**Justification**	**Amount**
	PC and software for Postdoc 7	***3300***
Task 7, Native And Alien Fish Population Trends: Other Direct	**Justification**	**Amount**
Task 7, Native And Alien Fish Population Trends: Indirect (Overhead)	**Justification**	**Amount**
		132910
	Task 7 Total	$265,820
Task 8, Project Administration: Labor	**Justification**	**Amount**
Cloern, James E., PhD.	***Cloern salary provided by USGS***	***0***
Knowles, Noah, PhD.		***26754***
Task 8, Project Administration: Benefits	**Justification**	**Amount**
Cloern, James E., PhD.		***0***
Knowles, Noah, PhD.		***5886***
Task 8, Project Administration: Travel Expenses	**Justification**	**Amount**
Conferences	***costs of two annual meetings with collaborators, customers***	***12000***
Other	***travel costs for PI's to two annual meetings with collaborators***	***12000***
Task 8, Project Administration: Supplies And Expendables	**Justification**	**Amount**

Office/Presentation Supplies	***illustrations, publication costs, poster presentations***	***14000***
Task 8, Project Administration: Subcontractors	**Justification**	**Amount**
No subcontractor was assigned to this task.		
Task 8, Project Administration: Equipment	**Justification**	**Amount**
Task 8, Project Administration: Other Direct	**Justification**	**Amount**
Task 8, Project Administration: Indirect (Overhead)	**Justification**	**Amount**
	Overhead on Knowles labor plus administration costs	***40265***
	Task 8 Total	$110,905
	Grand Total	$1,842,870

− The indirect costs may change by more than 10% if federal funds are awarded for this proposal.

What is the total of non−federal funds requested?

CASCADE: Computational Assessments of Scenarios of Change for the Delta Ecosystem [*]

"*Scenarios are a tool for helping us to take a long view in a world of great uncertainty*" (Schwartz 1991)

1. Purpose

Agencies of the CALFED Bay-Delta Authority (CBDA) have accepted a challenge of California resource management that is unprecedented in scope and complexity. CBDA programs will invest many billions of taxpayer dollars over decades to attain multiple, often conflicting, goals of resource allocation. Decisions made within CBDA have enormous potential impacts on California's $30 billion agricultural industry, quality of life of its growing population, and sustainability of diverse communities of native species and their supporting ecosystem functions. While the cost and scope of CBDA programs are large, the outcomes of cumulative CBDA actions are highly uncertain. For this reason, CBDA has embraced the principle that its goals of stabilizing water supplies, providing safe drinking water and restoring ecosystems can best be attained with investments in science building toward a mechanistic understanding to guide design and anticipate the potential outcomes of costly actions. This proposal describes a research project conceived as a step toward a long view (Carpenter 2002) of CBDA actions. The urgency of a long view comes from the certainty that forces influencing water supply and water and habitat quality in the Sacramento-San Joaquin Rivers and Delta will change in the future.

A recent assessment, based on a conservative rate of CO_2 emissions and two independent global climate models, projects that California's statewide annual temperature will increase by more than 1ºC by the mid-21st century (Hayhoe et al. 2004). Projected thermal expansion of the oceans and melting of polar ice will raise sea level 9-13 cm, annual snowpack in the Sierra Nevada Mountains will decline by 26-40%, and April-June reservoir inflow will decline by 11-24% as a result of reduced snowfall and earlier snowmelt. The combination of earlier runoff and higher sea levels will increase the risk of flooding (Hayhoe et al. 2004) and levee failures in the Delta more catastrophic than the 2004 levee break that flooded Jones Tract (http://www.publicaffairs.water.ca.gov/newsreleases/2004/jones04.cfm). Water demand will increase and landscapes will continually evolve as California's population adds 15 million people during the 30-year time frame of the CALFED Ecosystem Restoration Program (http://calwater.ca.gov/Programs/EcosystemRestoration/Ecosystem.shtml). Trends of reduced sediment input to the Delta (Wright and Schoellhamer 2004) and erosion of San Francisco Bay (Jaffe et al. 1998) will continue. And the Delta landscape will be transformed by structural changes designed to create new habitats or hold or transfer water (http://www.delta.dfg.ca.gov/erpdeltaplan/). This proposal is motivated by the **question**: How will these changes alter the Delta-River-Watershed system and its capacity to provide safe drinking water and sustain both rich communities of native species and California's irrigation-based agriculture?

The **goals** of this project are to develop and apply a model-based approach of ecological forecasting (Clark 2001) to project future states of the Delta ecosystem under prescribed scenarios of change, and to communicate the outcomes of those scenarios to resource managers facing the daunting challenge of meeting CBDA goals in a continually changing world. The **objectives** of this project are to:

[*] This entire proposal, including supplemental materials not included in this document, is available at our web site: http://sfbay.wr.usgs.gov/access/CF_Scenarios.

- Develop/refine/calibrate/verify a set of mechanistic numerical models of climate, watershed hydrology, Bay-Delta hydrodynamics, sediments and geomorphology, and water quality
- Link these models to project system dynamics from prescribed forcings, beginning with the climate system (including sea level) and then cascading to the watershed (water, sediment, contaminant runoff), river system (flow, heat, sediment and contaminant transport), and Delta-Bay (hydrodynamics, water temperature, salinity, primary productivity, suspended sediments, geomorphology)
- Compare projections under prescribed scenarios of within-Delta habitat change and catastrophic levee failures
- Apply model projections to assess changes in water and habitat quality, potential habitat expansion of key alien species (*Egeria*, *Corbicula, Potamocorbula*), incorporation of contaminants such as mercury and selenium into foodwebs, and qualitative population responses of native fishes
- Work in collaboration with CBDA agencies and interested stakeholders to develop flexible strategic plans based on a range of plausible, quantitative depictions of the BDRW system as it changes during the 21st century

2. Description

Design of this study is built from **hypotheses** that: (1) California's hydrology will change during the 21st century in response to global warming; (2) water management and ecosystem structure and function will respond to changes in California's water supply, population, land use, sea level, constructed habitats and storage-conveyance facilities, and potential levee failures; (3) sufficient information is available to project plausible ranges of change in each of these forcings; (4) climatic, hydrologic, hydrodynamic, water-quality, geomorphic and ecosystem processes are linked in the Bay-Delta-River-Watershed system, and thus models to project future conditions there must also be linked; and (5) strategic planning by CBDA will benefit from mechanistic, ecosystem-scale projections of future forcings and responses, posed as plausible scenarios of system change.

The research project described here is based on a **conceptual model** (Fig. 1) built from the following principles:

- San Francisco Bay, the Sacramento-San Joaquin Delta, their tributary Rivers and Watersheds are one system of interconnected landscapes (we will refer to this as the **BDRW system**).
- The primary linkage medium between these landscapes is surface water including precipitation, runoff, streamflow, and effects of storage, conveyances, consumption, and estuary-ocean exchanges.
- These hydrologic processes are primary drivers of change in the chemical, sedimentological, and biological properties of the BDRW system (and therefore the outcomes of CBDA actions).
- BDRW hydrologic processes will change during the 21st century due to altered global-scale external forcings and regional-to-local scale internal forcings.
- External forcings will reach the BDRW from the atmosphere (as variable air temperature, solar radiation, winds, precipitation, pressure) and from the coastal ocean (regional currents, sea level, tides, temperature).
- Internal forcings include modifications of land use (associated with economic and population trends), structural alterations within the Delta (levee failures, new storage or conveyance facilities or constructed habitats), and altered water operations.

- The overarching conceptual model guiding this project is that: (a) hydrologic processes in the BDRW system will be altered by changes in both external and internal forcings; and (b) system-level effects will include a cascading set of interconnected changes in Bay-Delta hydrodynamics and transports, sediment supplies and geomorphology, habitat and water quality, and distributions and abundance of native and alien species. Each of these cause-effect relationships is relevant to CBDA's four general goals (Fig. 1).

We propose to modify and link numerical models of key processes (Fig. 2) to explore likely responses to plausible future changes in the external and internal forcings that drive BDRW ecosystem dynamics. The changes to be considered will take the form of three types of scenarios (described in more detail below), to be considered separately at first and then in combination:

- Climate Change
- Population and Land Use Change
- Delta Configurational Change

The cascading effects of changes under these scenarios will be followed as they propagate from the climate system to watersheds to river networks to the Delta and San Francisco Bay (Fig. 2). The resulting linked modeling system will provide a scenario evaluation capability that may be used subsequently to assess a variety of possible management approaches to accommodating the projected changes.

The approach links, hierarchically, seven project elements:

① Climate Modeling and Downscaling
② Sacramento-San Joaquin Watershed and San Francisco Bay Modeling
③ Delta Modeling: Hydrodynamics with Temperature and Phytoplankton
④ Sediment, Geomorphology and Tidal-Habitat Modeling
⑤ Fate and Effects of Selenium, Mercury, Silver and Cadmium
⑥ Invasive Species– *Potamocorbula*, *Corbicula*, and *Egeria*
⑦ Native and Alien Fish Population Trends

These elements are described in the remainder of this section. The flow of information between project elements is shown schematically in Figure 2. For example, outputs from the climate element① (air temperature, precipitation, insolation) are required inputs to drive the hydrologic model②. Outputs from the hydrologic model (e.g. river discharge) are required inputs to drive the Delta hydrodynamic model③, and so on. This figure maps the specific input-output linkages to guide readers as they follow signal propagation from one model to the next.

Climate Modeling and Downscaling ①

Investigators – Michael Dettinger, Daniel Cayan, Noah Knowles

Problem – General-circulation models (GCMs) of the global climate project that increasing concentrations of atmospheric greenhouse gases will result in a warmer California (Cubasch and Meehl 2001), with temperature increases ranging from about 2 to 5ºC by the end of the 21st Century (Fig. 3). Projections of future precipitation in California are much more scattered, with most models yielding relatively small precipitation increases or decreases (Fig. 3). These changes are projected in the midst of a general tendency for the hydrologic cycle to intensify, so wet episodes become wetter and dry episodes become drier with global warming. Moreover, paleoclimate reconstructions indicate that long and frequent droughts have been more common

in California in past centuries (Fig. S-1)*, so a return to drought-rich conditions is a plausible scenario of California's 21st century climate. Related to climate change is the potential for warming-related rise in sea level, projected to be 20 to 90 cm by the end of the 21st century (Church and Gregory 2001).

The likely responses of California's watersheds, rivers, and (some) ecosystems to projections of future temperatures and precipitation have been studied and simulated in previous studies (e.g. Gleick 1987; Jeton et al. 1996; Knowles and Cayan 2002, 2004; Dettinger et al. 2004). Earlier snowmelt and runoff, larger and more frequent winter floods, and much drier summertime soil and riverine conditions are projected under all plausible scenarios. A more complete assessment of the potential impacts of climate change on the BDRW system requires inclusion of responses by the high-altitude and low-altitude, managed and unmanaged parts of the watershed and estuarine system, and inclusion of sea-level projections that are consistent with the climatic changes. Realistic projections of 21st Century conditions require inclusion of other forces of change that will occur concurrently with climate change, including population growth and alterations of Delta plumbing. We will identify and characterize linkages from climatic change to meteorological, hydrological, and sea-level responses as the starting place for multidisciplinary assessment of the future BDRW ecosystem.

We will develop several detailed climate-change scenarios, two serving as bookends representing the outer reaches of up-to-date projections, and a third scenario reflecting a future climate with more frequent or sustained droughts and warming, motivated by paleoclimatic results that suggest that such droughts have occurred more than once in California's past:

- Climate Scenario 1: large warming and sea-level rise, fairly stable precipitation
- Climate Scenario 2: small warming and sea-level rise, fairly stable precipitation
- Climate Scenario 3: medium warming and sea-level rise, extended droughts

Tools/Analyses – GCMs simulate climate on coarse (200 km) spatial grids. As part of efforts at Scripps Institution of Oceanography funded by the California Energy Commission, we have been collecting and analyzing simulations of 21st Century climate over California by almost a dozen different GCMs (Dettinger in press). These ongoing efforts will inform our decisions as to the most robust choices of climate scenarios for the proposed study. The collection of simulations will provide the daily-to-monthly climate series that will be "downscaled" for use in this study. Downscaling is the process of interpolating large-scale climate projections down to the local scales (1-10 km) necessary for input to watershed and hydrologic models. Some previous studies have used high-resolution regional climate models nested within the output from a GCM (e.g., Leung et al. 2004). We have examples of such "dynamically downscaled" scenarios from previous studies by the PIs, but, at present, dynamically downscaled scenarios are restricted to snapshots of a decade or so of future climate (by their high computational expense) rather than the continuous 200-yr scenarios that are needed for the proposed study. Thus we will primarily use examples of dynamically downscaled climate-change scenarios to help validate more readily generated statistically downscaled scenarios. Statistical downscaling methods include weather-typing approaches (e.g., Dettinger and Cayan 1992), stochastic weather generators (e.g., Jeton et al. 1996), multiple-regression methods (e.g., Wilby and Dettinger

* Figures designated with an 'S-' prefix are included in the supplemental material available on our website http://sfbay.wr.usgs.gov/access/CF_Scenarios. Clicking on the figure links embedded in the text should open the corresponding figure directly in your pdf reader or web browser. Figures not designated with an 'S-' are included at the end of this document, and can also be accessed directly by clicking on their links.

2000), and deterministic mappings (e.g., Dettinger et al. 2004). Statistical methods are trained to adjust various GCM outputs to match selected statistics of real-world weather observations. In the present study, a new version of the downscaling method of Dettinger et al. (2004) will be the starting point; under the auspices of the California Energy Commission-funded studies mentioned earlier, other, more physically based statistical methods may be developed and used to provide the required downscaled scenarios. The drought scenario will be produced from the historical record as conditioned by paleoclimate reconstructions to achieve specific scenario designs (e.g., Tarboton 1995).

Required Inputs – Climate-change projections for the 21st Century are available as monthly series of surface-air temperatures and precipitation from about eight coupled ocean-atmosphere GCM models (e.g., from http://ipcc-ddc.cru.uea.ac.uk/dkrz/dkrz_index.html). At present, we propose to acquire daily outputs from the National Center for Atmospheric Research's PCM and the British Hadley Center's HadCM3 models which yield, respectively, some of the coolest and warmest climate projections. We will choose among current models to best represent the current range of projected warming rates; thus the specific choice of models may change as our understanding and analysis of available climate-change projections evolves (Dettinger, in press).

Outputs – will be downscaled climate scenarios in the form of daily weather series at 200 stations for the 20th and 21st Century, with concurrent and consistent sets of sea-temperature and sea level variability and trends. A large number of stations specifically chosen to meet the input needs of the other modeling elements described below will be included among the 200 sites; but other sites that may be of use to other aspects of the CALFED Science Program also may be included. Climate variables will include daily surface-air temperature and precipitation, solar insolation, surface humidity, and sea level rise near the mouth of San Francisco Bay. Weather time series for each climate scenario will be the starting place for assessing BDRW responses through the hierarchically linked models depicted in Fig. 2.

Along with the specific climate-change scenarios described earlier, the overall statistics of an ensemble of as many up-to-date projections as can be obtained of 21st Century climate in the Bay-Delta watershed will be derived by the methods of Dettinger (in press), so that the likelihoods of the particular scenarios provided to the other project elements can be determined and communicated. For example, we will determine what percentage of all projections lie "between" the warmer and cooler scenarios; we will determine what percentage of projections fall between the drier and "unchanged" precipitation scenarios. These measures of the likelihoods of the scenarios will provide a crucial context for the uncertainty characterizations in the rest of the study, a context that all recent "bookending" studies of climate-change impacts in California have lacked. Additional scenarios that reflect other parts of the distribution of available climate-change projections will be provided to project elements that can use them. The primary climate scenarios described above will also be provided, online, to other studies that want to parallel our efforts.

Sacramento-San Joaquin Watershed and San Francisco Bay Modeling ②a,b

Investigators – Noah Knowles, Daniel Cayan, Michael Dettinger, Dave Peterson (with consultation from Hugo Hidalgo, DWR Modeling Support Branch, and USBR Division of Planning)

Problem – Changes in climate, land use, and freshwater demand must be translated into downstream hydrologic changes in order to produce a meaningful assessment of their ecological impacts. This element will develop and apply modeling tools to assess responses of the watershed and estuary to the three climate-change scenarios described above, in addition to Delta configuration change and human population/land use change scenarios (described below). Watershed models will simulate responses of streamflow and temperature above and below

major reservoirs, and salinity of Delta inflows. An estuarine model will be used to assess responses of salinity and residual currents in San Francisco Bay.

Tools/Analyses –

②a Hydrologic Model. At the core of this project element, the Bay-Delta Watershed Model (BDWM) is a physically based model of hydrologic processes that generate streamflow. It operates at a daily time step with primary inputs of precipitation and air temperature (Knowles 2000). The model simulates hydrologic variability in the entire Sacramento-San Joaquin watershed at a spatial resolution of 4 km. All model parameters are determined from fundamental physical considerations of soil properties, land cover, and topography, so BDWM requires minimal calibration and is uniquely well suited for studies of non-historical hydrologic scenarios as in this study. It is also computationally efficient, enabling the numerous simulations required to evaluate uncertainty (see below). The model simulates snow accumulation and ablation (using Tarboton and Luce 1996) and soil moisture fluxes, and contains a river routing component that integrates streamflow from throughout the watershed to determine total outflow. Figure 4 shows an example application of BDWM to assess potential hydrologic impacts from climate change projections through 2060.

An operations component will be coupled to BDWM, using DWR's CALSIM II (http://modeling.water.ca.gov/hydro/model/index.html). Changes in CALSIM hydrological inputs corresponding to the different scenarios will be derived from hydrologic simulations using the BDWM. These altered inputs will then be used by Dr. Hugo Hidalgo of Scripps Institution of Oceanography to drive CALSIM, and the results will be compared with outputs from a "base run" using unchanged inputs, providing an assessment of the role of management in translating upstream changes in hydrology, freshwater demand, and land use into downstream impacts, including changes in Delta inflows. The DWR Modeling support branch has agreed to provide additional assistance in validating and interpreting output from the CALSIM runs. The CALSIM simulations will also provide projections of the likely responses of Delta-inflow salinities to the scenarios evaluated. The USBR Division of Planning has agreed to apply their reservoir- and stream-temperature model RST to assess temperature changes under each scenario. The USBR model uses inputs of air temperature at selected stations, output from the CALSIM model, and monthly average reservoir inflow temperatures to compute monthly reservoir and stream temperatures at and below major reservoirs. Future reservoir inflow temperature variations will be estimated by developing statistical models of historical high-altitude stream-temperature responses to factors including air temperature and fractions of inflow composed of snowmelt and rainfall, and applying those models to the future climate projections.

②b SF Bay Model. The BDWM has been linked to the UP estuarine model (Uncles and Peterson 1995), which calculates daily salinity and axial residual currents in San Francisco Bay and Delta. The UP model reproduces patterns of salinity variability at weekly to interannual time scales over a wide range of flow regimes (Knowles et al. 1997), and is computationally efficient enough to allow the numerous runs needed to evaluate ensembles of climatic scenarios, allowing evaluation of uncertainty. Figure S-2 shows the potential estuarine impact of the projected upstream 2060 hydrologic changes (Fig. 4). These results do not yet include effects of sea level rise, management adaptations, or potential Delta configurational changes, all of which will be included in the proposed scenario evaluations, providing a more complete assessment of the interactions of the various potential influences and their ultimate impact on the estuary.

Required Inputs – For each climate-change scenario, estimates of sea level, sea temperature, air temperature, specific humidity, insolation, and precipitation over the watershed will be provided as described in the climate element①. The land-use/population change scenarios require forecasts of changes in the watershed including urbanization, farmland conversion, and changes in freshwater demand patterns due to population trends. This information will be obtained through DWR Modeling Support Branch for projected 2030 conditions (these data are

currently in preparation for Bulletin 160-04, the California Water Plan Update: http://www.waterplan.water.ca.gov/b160/indexb160.html). For scenarios where in-Delta effects on Delta outflow are deemed significant, output from Delta TRIM③ will drive the UP model; otherwise outflows from BDWM②**a** will drive UP directly.

Outputs – will be salinity and residual currents throughout the estuary, inflows from the watershed via the Sacramento, San Joaquin, and "east side" rivers, and flow rates, salinities, and temperatures in the rivers of the watershed. Flows, temperatures, and estuarine salinities will be simulated daily for the 20th and 21st centuries to provide representations not only of trending conditions, but also of plausible daily-interdecadal variations in the altered system. The hydrologic and estuarine models will provide altered salinity, inflows, and temperatures at the Delta boundaries for use in the Delta modeling element③. Projected changes in streamflow rates, temperatures, and salinity in the watershed will be used by the sediment-geomorphology④, contaminants⑤, invasive species⑥ and fish⑦ elements in addition to more detailed outputs produced by the Delta modeling element③.

In addition to the outputs corresponding to the specific scenarios described above, the ensembles of up-to-date climate projections described in the climate element① will be used to drive corresponding ensemble simulations of the BDWM, CALSIM II, and UP models. This will allow provision of ensemble outputs of Delta inflow and river and estuarine salinity, among other quantities, to those project elements that can use them. Further, these ensemble runs will allow characterization of the specific scenario outputs from these models in terms of the quantitative "bookending" probabilities described in the climate element①, allowing the estimates of uncertainty to be propagated more completely to other project elements.

Delta Modeling: Hydrodynamics with Temperature and Phytoplankton ③

Investigators – Nancy Monsen, Lisa Lucas, James Cloern, Postdoctoral position to be hired (with consultation from Mark Stacey)

Problem – The Delta is the central hub that links hydrologically driven variability in the watersheds and rivers to the estuary. It supplies drinking water to 23 million Californians, is habitat for native species, provides a conduit supplying water to the State Water Project (SWP) and Central Valley Project (CVP), sustains diverse agriculture in farmlands protected from inundation by vulnerable levees, and will be transformed by CBDA actions to build new habitats and water storage-conveyance facilities.

Climate-driven hydrologic change and sea level rise will potentially lead to profound changes in hydrodynamic processes within the Delta, including those controlling water transport, quality and temperature. In addition, anthropogenic changes, including new Delta structures, and catastrophic levee failure may also occur during the next 50 years and could significantly change transport through the Delta. We will apply a high-resolution hydrodynamic model (Delta TRIM) that runs in 2-D (depth-averaged) or 3-D mode to assess transport, water quality and temperature responses to the prescribed scenarios of climate change, population and land use change, and physical changes to the Delta. These scenarios will help assess the significance of changes in circulation due to climate and population change compared to those due to physical changes in the Delta.

Tools/Analyses –There will be three separate yet interconnected modeling components: a) Delta hydrodynamic modeling (stage, velocity, and scalar transport), b) temperature modeling, and c) phytoplankton dynamics (modeled as biomass and primary production). The core routines in Delta TRIM are the TRIM3D hydrodynamic model (Casulli and Cattani 1994) and the transport routines developed by Gross et al. (1999). Delta TRIM computes tidal-scale water motions using a fine scale (50 m) computation grid that resolves currents and stage in the small, interconnected channels characteristic of the Delta. Monsen (2001) incorporated Delta-specific

operations such as gate operations, pumping and agricultural diversions and returns into the TRIM3D model, and created the associated bathymetric grid. The model has been calibrated and verified (depth-averaged 2D mode) by comparing model results to measurements throughout Suisun Bay and the Delta for several time periods spanning a range of inflows and operational manipulations. An example application (Fig. S-3) shows spatial variability of source water in the interior Delta.

Dr. Mark Stacey (University of California Berkeley) and graduate students are currently developing a 3D temperature model (based on Rosati and Miyakoda 1988) coupled to TRIM3D for analysis of heating and cooling in Mildred Island, a sub-domain of the Delta. The temperature model is being calibrated against an extensive dataset collected from a current CALFED-funded study (Fig. S-4), but it has not been extended to the complete Delta domain.

We propose to also model trends in Delta phytoplankton biomass and production because previous studies have demonstrated that phytoplankton primary production is the most important source of organic matter fueling secondary production in the Delta (Jassby and Cloern 2000). Phytoplankton biomass is the dominant food supply to the Delta's planktonic food webs that produce forage for larval and juvenile fish (Sobczak et al. 2002). Delta-wide primary production is low compared to estuaries globally, and this damped food-supply function leads to food limitation of freshwater zooplankton such as cladocerans (Mueller-Solger et al. 2003). Delta-wide primary production has declined significantly in the past three decades (Jassby et al. 2002), and we will apply an existing model (TRIM-BIO) to project future changes under the set of scenarios prescribed above. TRIM-BIO is a depth-averaged hydrodynamic model (TRIM2D) with incorporated depth-averaged phytoplankton dynamics, developed by Lucas et al. (1999) to study interactions between hydrodynamic processes and phytoplankton dynamics in shallow estuaries (Fig. S-5). Modeling work under a current CALFED grant involves adapting the TRIM-BIO biological module for use with the TRIM3D hydrodynamic model for two sub-domains of the Delta (Franks Tract and Mildred Island). The biological module will calculate the time- and space-dependent photosynthesis, respiration and growth rate of phytoplankton, as well as consumption by zooplankton and benthic consumers, while they are transported through the Delta domain. Phytoplankton growth and losses to grazing will be modeled as by Lucas et al. (2002) and Lucas and Cloern (2002).

We have selected TRIM3D as the base Delta hydrodynamic model for a variety of reasons. First, the hydrodynamic code and transport routines appear extensively in the peer-reviewed literature. Gross et al. (1999) showed that the transport scheme conserves mass, a key attribute for biological models. Second, the model is multidimensional. This allows us to better represent exchange between the shallow water environments and the channels. Third, depth-dependent friction factors are used to calibrate TRIM3D. Because this tuning factor is globally valid, specific regions within the Delta TRIM domain do not have special tuning coefficients. Therefore, bathymetric changes to the system can be modeled without invalidating the model calibration. Fourth, Lucas has previously demonstrated the ability to couple phytoplankton and hydrodynamics with TRIM for a South Bay application (Lucas et al. 1999a, Lucas et al. 1999b). Fifth, the work of linking the temperature module with TRIM is already in progress.

The first phase of the Delta modeling effort will involve model enhancements required to address the climate change scenarios. 1) The bathymetric grid for the Delta TRIM model will be improved and the Sacramento River boundary relocated so the model can use flow input data from BDWM② and calculate transport through the Yolo Bypass. Once the bathymetry grid is modified to include the Yolo Bypass, the Delta TRIM model will be re-calibrated and verified both in 2D (depth-averaged) and 3D modes using existing datasets from several time periods spanning a range of inflows and operational manipulations. 2) The domain of the temperature module will be expanded from the current sub-domain around Mildred Island to include the proposed extended domain of Delta TRIM (Delta, Suisun Bay, and the Yolo Bypass). The

temperature module will be calibrated and verified both in 2D (depth-averaged) and 3D modes against water temperature measurements throughout the Delta using light attenuation as the tuning parameter. 3) The phytoplankton modeling will also be expanded to include the full Delta TRIM domain after the calibration and verification of the temperature module is completed. In the second phase of the Delta modeling effort, the models will be used as a tool to investigate both physical and climate changes to the system. Because Delta TRIM is highly resolved spatially, the model runs will be limited temporally to a 3-6 month period for each scenario. We will perform 3D simulations for two or three scenarios where we anticipate salinity intrusion or temperature stratification to be important (i.e. reduced summer inflows due to warming or the levee failure scenario). The other scenarios will be run in 2D depth-averaged mode.

Errors associated with the Delta modeling element of this project will be determined by comparing model output for historical cases with measurements for simulation periods that encompass both wet and dry seasons and a range of habitats (e.g. deep channels, shallower open water areas). Calculated velocity, stage, flow, salinity, temperature, and phytoplankton biomass from the base hydrodynamic model, temperature module, and biological module will be compared with local- and Delta-scale measurements. These data will include measurements from previous studies including current CALFED-funded measurements in the Mildred Island, Franks Tract, and Three Mile Slough. We will also use data from the USGS flow network and IEP'S Environmental Monitoring Program (stage, salinity and temperature stations throughout the Delta). Metrics to be used for quantifying the comparisons may include magnitude and phase errors derived from harmonic analysis for tidally influenced parameters (e.g. flow, stage) and bulk quantities such as net flow and tidally or spatially averaged salinity, temperature, and chlorophyll.

Required inputs and outputs are described in the following (*Figure S-6 contains a summary of all the required inputs for all the models, the sources of the data for each simulation*).

Base Delta TRIM hydrodynamic model

Inputs – Two scenarios of altered Delta bathymetric configuration will be compared to the baseline Delta physical configuration of 2003 using historical data to drive hydrologic boundary conditions. The first scenario of intentional channel transformation is based on structural changes described in the CBDA Conveyance Program Multi-Year Program Plan (Fig. 5). The second scenario of unintentional reconfiguration depicts catastrophic levee failure from a large earthquake, based on the CALFED Levee System Integrity Program Plan (Fig. 6). Delta TRIM is driven by boundary conditions of river inflow (provided either from historical data or BDWM②**a**), and tide stage at Martinez (provided either from historical data or the climate element①). Time-varying salinity at the upstream and downstream boundaries for the climate change scenarios will be provided by BDWM②**a** and UP②**b**, so this model will process inputs from three prescribed physical representations of the Delta and output from three models driven, ultimately, by GCMs (see Fig. 2).

Outputs – For each (3-6 month) simulation experiment, Delta TRIM will compute tidal and residual current speeds and directions, stage, salinity, source water mixture, and residence time across a 50-m grid over the full Delta domain. These outputs will provide projections of the future Delta under the scenarios described, including the following responses: timing and duration of Yolo Bypass inundations, salinity and source-water mixture at municipal intakes or export pumps, transport routes and rates throughout the Delta.

Temperature model

Inputs – Meteorological data (air temperature, wind speed, and solar radiation) determine the heat input to the temperature module. The Delta TRIM hydrodynamic model is used to

determine horizontal transport and vertical mixing (Mellor-Yamada 2.5 turbulence closure routine). For the physical change scenarios, observed temperatures at stations near each boundary and meteorological data from stations within the Delta will drive the model. GCMs① will provide the meteorological data. The USBR model②**a** will provide river boundary temperature data. GCMs, coupled with historical temperature profiles in SF Bay, will be used to develop statistical models to drive the western (bayside) temperature boundary condition.

Outputs – Temperature modeling will provide seasonal temperature distributions throughout the Delta. For the scenario runs in 3D, the percent of stratified area within the Delta will be calculated. Temperature distributions are key information for both the invasives⑥ and the fish⑦ elements of this proposal. Key questions to be addressed are: 1) How do shifts in timing and flow through the Yolo Bypass change the heat budget of the Delta, 2) What percent of the Delta is likely to stratify and for how long, and 3) What regions of the Delta will become warmer or cooler compared to the base case?

Phytoplankton model

Inputs – Effective phytoplankton growth is a function of water depth, water temperature, solar irradiance (PAR), light attenuation coefficients (derived from suspended sediment concentrations), nutrient concentrations, benthic grazing rates, and zooplankton grazing rates. As with the temperature model, Delta TRIM drives horizontal transport and vertical turbulent mixing of phytoplankton biomass. The water temperature will be calculated at each time step immediately before the phytoplankton subroutines. For the physical change scenarios, observed meteorological data will provide solar radiation, and light attenuation coefficients will be estimated from existing field data. For the climate change scenarios, GCMs① will provide meteorological data and the sediment transport element④ of this proposal will assist with estimation of light attenuation coefficients. Zooplankton grazing estimates will be based on the work of Lopez et al. (in review). Nutrients will be assumed replete for all scenarios, based on assessement of IEP monitoring data demonstrating that nutrients rarely limit algal growth in the Delta (Jassby et al. 2002). Boundary conditions for phytoplankton biomass transport into the system will be based on discrete and continuous chlorophyll *a* measurements by CDWR near the domain boundaries. We will examine historical chlorophyll *a* correlations with environmental variables (e.g. flow, temperature, and EC) to create a method to set boundary conditions for future scenarios.

Benthic grazing estimates will be based on an extensive survey of the benthos performed during a current CALFED-funded project, as modified by the invasive species element⑥ of this project. The phytoplankton-modeling element will provide a check on the phytoplankton biomass estimated within STELLA⑥ for developing benthic grazing rates.

Outputs – For scenarios resulting in extreme changes in transport rates (i.e. residence times), vertical density stratification, turbidity, grazing, or average water depth, we will calculate projected changes in the distribution and export of phytoplankton biomass. Phytoplankton primary productivity (PP) is the major metric by which we will compare various scenarios to the current Delta, thus questions we propose to answer include: 1) For a given scenario, does PP increase or decrease? 2) If PP increases, where (geographically, mechanistically) does the increase come from? 3) If PP decreases, what is the mechanism? Hydrodynamic flux, grazing, and growth rates will be quantitatively compared to generate a mass balance and answer these questions.

Sediment, Geomorphology and Tidal-Habitat Modeling ④

Investigators – David Schoellhamer, Bruce Jaffe, and Neil Ganju

Problem – Sediment transport and geomorphology are fundamental to the creation and

maintenance of tidal habitats. The prescribed scenarios will affect the evolution of San Francisco Bay-Delta tidal habitats. We will link separate models of Delta sedimentation, sediment supply to the estuarine subembayments, and subsequent ocean exchange, sediment redistribution, and geomorphic evolution within the estuary (Fig. 7). The models will be as simple as possible so that we can hindcast 130 years of bathymetry data, simulate 100 years into the future, and run numerous simulations to evaluate uncertainty, simulate stochastic hydrology, and evaluate multiple scenarios.

Tools/Analyses – We will construct and link models to compute: (1) Delta sedimentation– changes to the Delta sediment budget by Wright and Schoellhamer (submitted, Fig. S-7) will be estimated by estimating loads and distribution as a function of freshwater inflows. (2) Sediment supply to the subembayments of the estuary– this is the primary factor affecting geomorphic evolution and habitat creation (Fig S-8). A one-dimensional or modified Uncles-Peterson multi-box model (Lionberger 2003) will be used. (3) Sediment deposition and redistribution within subembayments of the estuary– the public-domain ROMS model (http://marine.rutgers.edu/po), which was used previously to model hydrodynamics and sediment transport in Suisun Bay (Warner et al., 2004) will be refined and tested for sediment supply and redistribution simulations, and long-term geomorphic evolution simulations. Presently, the refined model is being developed for Suisun Bay in collaboration with UC Davis through a University of California Water Resources Center Grant. A combination of the Delft 2DH (Roelvink et al. 2001) and 3D (Winterwerp 2001) coupled hydrodynamic, sand and mud transport models and morphology models within the Delft3D system (http://www.netcoast.nl/tools/rikz/delft3d.htm and http://www.wldelft.nl/soft/d3d/intro/) will be used in San Pablo Bay. Delft models are currently being used by Dan Hanes and Patrick Barnard, USGS, to model sediment exchange between the estuary and ocean. The knowledge gained from the ROMS and Delft models will be used to formulate a simplified model of geomorphic response to scenarios. Once the models are crosschecked and validated for benchmark cases, use of these two models optimizes existing collaborations and resources and improves confidence in the models by allowing comparison of results. (4) Future geomorphology of San Francisco Bay– the geomorphic model will compute tidal and wind wave redistribution of sediments and the subsequent evolution of shallow-water habitat, mudflats, and tidal wetlands (Fig. S-9). Geomorphic modeling techniques, including input filtering, empirical relations, and process-based modeling will be implemented and compared.

Required Inputs – For model calibration and validation, we will use the large database compiled by USGS and other agencies on bathymetry (Jaffe et al., in press; Jaffe et al. 1998; Capiella et al. 1999; Foxgrover et al. 2004), suspended-sediment concentration (Buchanan and Ganju 2004), and tributary inflow. Flow from the Delta and east side rivers will be provided by the watershed modeling element②**a**, in the varying scenarios created by the climate modeling team. Inputs to the Delta sedimentation model will be water discharge and a sediment rating curve developed by extrapolating data presented by Wright and Schoellhamer (2004). Inputs to the sediment delivery model will be water and sediment yield from the Delta sedimentation model, rate of sea-level rise from the GCMs①, and the Delta structural configurations prescribed above (in ③). Inputs to the geomorphic evolution model will be output from the sediment delivery model, sediment delivery from local tributaries (estimated by regression of historical sediment loads on flow rates), and sea level rise and wind climatology from the GCMs①. Historical Suisun Bay (Capiella et al. 1999) and San Pablo Bay (Jaffe et al., in press; Jaffe et al. 1998) bathymetric analyses of the past century will be used to test the Bay geomorphology model.

Outputs – We will estimate changes in Delta sedimentation for each climate change scenario. The sediment supply model will route sediment from the Delta to the subembayments of the estuary. The geomorphic evolution models will determine altered bathymetry in San Pablo and

Suisun Bays, which will be applied in the UP model②**b** to estimate resulting changes in salt transport into the Delta. In addition, geomorphic evolution models will simulate long-term changes in depth, and therefore habitat evolution within San Francisco Bay, which will be used by the invasives⑥ and fish⑦ studies in this proposal.

Fate and Effects of Selenium, Mercury, Silver and Cadmium ⑤

Investigator – Robin Stewart

Problem – Pollutant effects in San Francisco Bay are tied in complex and interactive ways to hydrology, hydrodynamics, sediment transport, ecological processes and food web structure (Fig. 8). Four metals have been shown specifically to have adverse effects: selenium has disrupted food webs in the Central Valley (Luoma and Presser 2000); health advisories constrain human consumption of Bay-Delta fish because of mercury contamination and both silver and cadmium have historically impaired invertebrate growth in South San Francisco Bay (Hornberger *et al.* 2000; Brown *et al.* 2003). These metals have distinct origins and delivery pathways: Se from the San Joaquin Valley and refineries, Hg from the Sacramento River, Cd from mining in the Shasta district (Cain *et al.* 2000), Ag from local watersheds. The concentrations of these toxicants in the Delta and Bay vary with loadings from the source, amount of runoff, changes in sediment load, chemistry of the runoff, and the source of runoff. The effects of the contaminants are determined by their concentration, chemistry and bioavailability in the Bay or Delta. The goal here is to contrast how future hydrologic scenarios might alter concentrations of the contaminants, and the implications of those changes for bioavailability and potential adverse effects.

Tools/Analyses – We will extend to the four contaminants the approach used to compute selenium effects in San Francisco Bay for varying scenarios of altered loadings, developed by Luoma and Presser (2000). The approach establishes metal loadings scenarios from source-specific information. Inflows to the Bay (including source and chemistry) are used to determine concentrations. Partitioning coefficients and speciation are used to differentiate particulate and dissolved concentrations; a dynamic bioaccumulation model (DYMBAM, Schlekat *et al.* 2001) calculates uptake by the first trophic level; then empirically derived trophic-partitioning constants are used to calculate trophic transfer through the foodweb. For example, Luoma and Presser (2000) used this approach to propagate Se transfer through a bivalve-based food web to compute bioaccumulation in sturgeon and scaup (Fig. S-10). The approach will be applied to assess bioaccumulation, trophic transfer, and potential effects of four metals on predators⑦ from different food webs: invasive predators that feed from the water column (e.g. striped bass for mercury and selenium) and native predators (e.g. Sacramento splittail and/or sturgeon, which feed on bivalves⑥).

Required Inputs – Loading data for mercury and cadmium are available from the existing literature, and will be assembled for this study. Model bioaccumulation coefficients for mercury and cadmium are being developed for invertebrate species and for fish (Croteau, in preparation; Fisher, N. SUNY, CALFED ERP-02 P40). For silver, coefficients for uptake by invertebrates are available and those will be used for model projections. No food web analyses will be conducted for silver, because most effects appear to occur on lower trophic levels. Input from other project elements will be used to define different scenarios of source loading and/or runoff influences. For example, if inflows from the SJR increase relative to Sacramento R. inflows (from ②**a**), Se loads to and concentrations in the Bay-Delta will increase. The timing of such increases is crucial to determine Se exposures of migratory predators (information from fish element⑦). Similarly, if Sacramento R. inflows increase relative to the SJR, mercury and cadmium loads and concentrations could increase. If the timing of river flow changes, this will affect dilution of silver from internal sources, perhaps influencing the potential to affect reproduction in

invertebrates (timing of reproduction determined by the biological elements of the project⑥,⑦).

Outputs – For each scenario, we will compare projected monthly inflows, sources, sediment loads and either metal loadings or metal concentrations using flow outputs from BDWM② and transports computed by Delta TRIM③. The bioavailability/effects model will then be used to constrain influences of these changes on upper trophic level animals. The output will be a comparison, under different Delta scenarios, of potential stresses to selected invasive and native predators from different food webs. This stress can be one of the considerations in determining the suitability of ecological conditions in both the fish⑦ and invertebrate⑥ elements of the project.

Invasive Species– *Potamocorbula*, *Corbicula*, and *Egeria* ⑥

Investigator – Janet Thompson

Problem – One of the ERP goals is to "reduce the negative impacts of invasive species". We will look at three species that have displayed significant ecosystem effects and that have been sufficiently studied to allow us to project their distribution in response to the scenarios described in this proposal. Two of these species, the filter-feeding bivalves *Potamocorbula amurensis* (*PA*) and *Corbicula fluminea* (*CF*), have previously been shown to change the food web by controlling the biomass of phytoplankton at the base of the food web (Fig. S-11, Alpine and Cloern 1992, Lucas et al. 2002). These alien bivalves have the potential to impede progress of CALFED's ERP by consuming zooplankton, outcompeting native zooplankton, shrimp, and larval fish for food (Kimmerer 2002), and increasing the trophic transfer of contaminants (Stewart et al. 2004, Linville et al. 2002). The third exotic species, *Egeria densa* (*ED*), is a perennial freshwater submerged macrophyte that occupies about 8% of the surface area of the Delta and has transformed the shallow water habitat in the Delta to one that is now dominated by a denser (leaves and plants), more widely distributed, less seasonally variable, and more shade-tolerant species than was there before. As summarized by Brown (2003), the fish community in *ED* tends to be dominated by alien species and the edge of the *ED* beds dominated by alien piscivorous fish, so the few natives that appear to benefit from the food and refuge available in the *ED* are potentially more likely to be preyed upon. Areas such as Suisun Marsh, which presently has no beds of *ED,* may be prime restoration areas (Brown 2003) and it is important that we be able to understand conditions which may encourage *ED's* spread. Thus, we will assess potential changes in the distribution, biomass, and food consumption of *PA* and *CF*, and in the distribution and relative density of *ED*, for each scenario.

Tools/Analyses – We will construct several statistical models (e.g., GAM, logistic regression and CART) of the three species to estimate their potential distribution in the Bay and Delta for each scenario based on their known physiological tolerances and field distribution data (Fig. 9). Validity of all models will be determined by comparison to the following field data: (1) *Potamocorbula's* population structure and distribution since 1986 (Thompson 2004 and unpublished data); (2) *Corbicula's* present distribution (Fig. S-12, Parchaso and Thompson 2004), growth rates (USGS unpublished data, Foe and Knight 1985), and its population structure and recruitment history as reported by the CA Dept. of Water Resources Environmental Monitoring Program since 1977; and (3) *Egeria* distribution as reported by the CA Dept. of Boating and Waterways (2001) and the *Egeria* Project at the Romberg Tiburon Center (http://romberg.sfsu.edu/~egeria/). In addition, we will estimate biomass distribution for specified habitats in the Bay/Delta for CF and PA using a relatively inexpensive, "off the shelf" modeling program, STELLA (Ruth and Lindholm 2002). Both of these species dominate the community when they are present, recover quickly from disturbance, and interspecific competition does not appear to be a limiting factor for either species (Nichols et al. 1990, Thompson 2004, McMahon 1999). Thus we believe there is potential for successful multi-

dimensional landscape models of these species that dynamically link to hydrographic and phytoplankton models at some time in the future. We expect the STELLA models to give us order-of-magnitude estimates of biomass (and thus of grazing rate), and to highlight the life history parameters most in need of study before larger modeling efforts are attempted. Data will be reported by habitat type which will be defined by the environmental factors determined to limit the distribution of each species, based on the statistical modeling effort.

Two types of errors will be reported for predicted distributions based on statistical tools. The first type of error, that associated with the statistical method, is easiest to calculate. The second type of error is that in which the presence of an organism is predicted at a location where they are not present, or conversely, due to some unmeasured environmental factor. This type of error is more difficult to assess. Therefore we will establish that the predictions are potential distributions within the statistical error limits. Errors associated with rate parameters (e.g., growth), environmental variables (e.g. temperature), and model numerics (reviewed in Ruth and Lindholm 2002) will be assessed by running STELLA in Monte Carlo fashion with random sampling from parameter and input variable distributions. Overall error will be determined by sampling from all input and parameter distributions simultaneously, and the sensitivity of the species density and biomass to the model parameters will be established by applying this error propagation approach to each parameter separately. This sensitivity analysis will increase our understanding of the species and also help establish which errors are most important in our predictions. We will use this knowledge to reduce the error where possible, or at a minimum know which parameters are most important in our error propagation analyses. Model results for present-day conditions will be compared against known distributions and biomass values for the species during wet, dry and average hydrologic years to demonstrate the ramifications of these errors.

Required Inputs – Distribution models will require future scenarios values for seasonal streamflow, water temperature and salinity, phytoplankton biomass, current velocity, flood frequency, turbidity, and habitat evolution produced from the modeling elements described above (②**a,b**, ③, and ④). STELLA will require some of these same environmental variables in addition to biological estimates of rate of cohort (age)-specific growth and mortality, fecundity, recruitment, immigration, and emigration at a minimum. The Bay/Delta is in the mid-latitudinal range for both of these exotic bivalves and preliminary work by the USGS and others has shown that growth rate, reproductive rate, fecundity, and recruitment are most closely related to food and temperature in this system. Therefore these rates will be estimated through a combination of published rates and analysis of local field data (Fig. 9). Phytoplankton biomass will thus be required to run STELLA. Unfortunately, neither the time step or the sophistication of the population models can match with those of the TRIM ③ phytoplankton module at this time, and we will need to develop a submodel to estimate phytoplankton biomass assuming a local balance between phytoplankton growth rate and bivalve grazing rate (phytoplankton biomass will change as function of ③ and ④ model-derived values of temperature and turbidity, and published estimates of zooplankton grazing and irradiance). Phytoplankton biomass in this simple model will be reduced by a parameter derived from phytoplankton growth rate (from TRIM③) and clam grazing rate during each month, if needed (e.g., if depth-normalized grazing rate is twice the growth rate of phytoplankton, the biomass level will be reduced by half as a first estimate). Seasonal phytoplankton biomass will be compared to that predicted by TRIM (using the newly derived benthic grazing rates) and will be adjusted if needed. If necessary, we will iteratively run the STELLA models with TRIM to insure the correct benthic grazing rate is being applied for the appropriate phytoplankton biomass levels in TRIM. Initial conditions in the model will assume population structure and species distributions that are consistent with what we find today. A short "conditioning" period will be used to stabilize the phytoplankton submodel and clam growth model at the beginning of the model runs.

Outputs – will include, for each scenario: (1) Seasonal estimates of the distribution for *Egeria*, *Corbicula and Potamocorbula* based on habitat type, throughout Suisun Bay and the Delta; (2) Spatial distribution of the seasonal biomass levels and grazing rates for *Corbicula* and *Potamocorbula* based on habitat type; monthly data will be available as required for critical periods in the TRIM phytoplankton module and contaminant metals models. Grazing rates will be estimated as described in Lucas et al. (2002) and Thompson (2004).

Native and Alien Fish Population Trends ⑦

Investigator – Larry R. Brown

Problem – Restoration of native fish populations is a significant goal of CALFED's Ecosystem Restoration Program (ERP). Various management strategies are presently being considered or implemented to accomplish such restoration; however, it is unclear if the benefits of such strategies would be maintained in response to the hydrologic and physical changes in ecosystems that could occur in response to changes in climate, water use, and physical configuration. Fish species of the BDRW system are affected by many environmental factors (Bennett and Moyle 1996), including those responsive to climatic-hydrologic change (Fig. 1): salinity distribution as indexed by "X2" (Jassby et al. 1995, Kimmerer 2002); timing and duration of floodplain inundation (Sommer et al. 2001); flow and temperature as they affect spawning and growth (Feyrer and Healey 2003); the balance between native and alien fishes (Brown and Ford 2002); habitat quality as influenced by the distribution of *Egeria densa* (Brown 2003); stream temperature as it affects anadromous salmonids during upstream migration, spawning, and rearing (Moyle 2002); and high flow events that mobilize streambeds resulting in the loss of incubating eggs, or move larvae into unsuitable areas. The objective of this element is to determine if populations of selected native and alien fish species are likely to increase, decrease, or remain constant in response to environmental changes expected based on the scenarios defined above.

Tools/Analyses – This project element will include two tasks. The first task will be to maintain communication with fisheries resource managers. Communication is needed so that the project team can remain informed about the critical information needs of managers, managers can remain informed about the progress of other project elements, and managers can remain informed about the degree to which the project team will be able to meet their needs. The PI will convene a committee of agency and academic scientists to fulfill this task. The group will meet face-to-face at least once a year with additional communications by e-mail and other methods as warranted.

The second task will be to assess potential population responses through integration of quantitative depictions of future environments with species-specific ecophysiological and life-history information for target species. Assessments will comprise a series of subtasks:

- Construct a qualitative life-history model (e.g., Fig. 10) based on existing information for each species of interest. For some species, models already exist (e.g., striped bass, splittail, anadromous salmonids). For others, models will have to be constructed from the literature and local information. The models will identify the periods in the life cycle when each species would be most vulnerable to changes in temperature, salinity, flow, and habitat changes.
- Assess the likely population effects of the scenarios by comparing outputs of salinity and temperature distributions with salinity and temperature preferences/tolerances of native and alien fishes.
- Assess the likely population effects of the scenarios by comparing outputs of flow patterns with available information on the responses of native and alien fishes to flow regime.
- Assess the likely population effects of the scenarios regarding the fate and effects of selenium, mercury, silver and cadmium for the species modeled.

• Assess the likely population effects of changes in the distribution and density of *Egeria densa* to the extent possible given values and confidence in predicted salinity field, water temperatures and bathymetry from the Delta models.

• Predict overall responses (positive, negative, neutral) of fish populations to changes in temperature, salinity, flow, and habitat predicted by the scenarios.

• Summarize the predictions for the individual species into an integrated prediction for the fish community as a whole.

It is likely that sufficient information is available to construct life-history models for most of the common native and alien species. Evaluations of individual species responses will likely progress from professional judgment and simple conceptual models to predictions from simple qualitative models, such as loop analysis (Puccia and Levins 1985). The qualitative approach is necessary because actual population sizes of most fish species in the Delta are unknown, making quantitative evaluations impossible.

Required Inputs – For Task 2, assessments of population responses will begin with outputs from GCMs①, BDWM②**a**, Delta TRIM③, UP②**b**, and the geomorphic models④ as future scenarios of air and water temperature, seasonal streamflow and salinity distributions, Bay-Delta circulation patterns, flood frequency and floodplain inundation, and habitat mosaics. Assessments of the effects of changes in contaminants will be limited to the species modeled by Stewart⑤. Presently, such models are planned for striped bass, Sacramento splittail, and white sturgeon. Assessments of the distribution and relative density of the alien macrophyte *Egeria densa*⑥ will also be incorporated to the extent possible. Salinity, temperature and habitat preferences/tolerances of native and alien fishes will be determined from the literature. Responses of various species to changes in flow regime, such as severity and frequency of flood events and inundation of floodplain will also be assessed from the literature. Data collected by the Interagency Ecological Program and other local programs will be evaluated including fall mid-water trawl, summer townet, 20-mm survey, and Delta resident shoreline fish monitoring. Sufficient literature or local information must be available to construct a life-cycle model for each species to be assessed. Existing, locally derived life-cycle models will be utilized if available.

Outputs – Task 1 will inform all the project elements about the information needs of managers. Outputs of Task 2 will include: (1) a simple life-cycle model for each alien and native species considered; (2) an assessment of the likely population effects for those species of changes in temperature, salinity, habitat, and flow regime; and (3) an integrated community assessment of such changes representing visions of trends of fish community responses to a range of future conditions in the BDRW system.

3. Justification

Relevance to CBDA. Our goal is to link a multidisciplinary suite of analyses and models of the Bay-Delta-River-Watershed system to assess the likely outcomes from a set of scenarios. This effort will provide the basis for a new framework to help resource managers anticipate and plan for changes in California's water and ecosystem resources, in keeping with the programmatic objectives of the CALFED Bay-Delta Authority. Scenarios are used by innovative businesses to provide "*a context for thinking clearly about the impossibly complex array of factors that affect any decision*" and "*to make strategic decisions that will be sound for all plausible futures*" (Schwartz 1991). Clear thinking and sound decisions are going to be needed as the CALFED Ecosystem Restoration Program (ERP) implements the 300 targets and 600 programmatic actions envisioned in its Strategic Plan.

The urgency of developing a long view for CBDA planning was prominent in plenary

talks given by leading scientists at the 2004 CALFED Science Conference:

- "*Substantial increases in levee instability and associated failures will occur over the next 50 years, and thresholds may be crossed that lead to widespread multiple-island flooding events. All other CALFED/CBDA programs, specifically water supply reliability, drinking water quality and ecosystem restoration, will be significantly and negatively impacted by these events*." (Jeffrey Mount).
- "[The long-term future of California's native fishes] *is cloudy given the certainty of long-term drought, climate change, sea-level rise, collapse of levee systems (especially in the Delta), new invasive species, and increasing human populations… If we do not plan for the major changes in California's aquatic ecosystems that are likely within the next 25-50 years, we will need expensive and temporary emergency measures to fix things following each successive disaster*." (Peter Moyle).
- "*To meet our goals of restoring ecosystem function and preserving species in California aquatic systems, while continuing to supply our present and future water needs, requires that we … understand the functioning of present complex systems and simulate future response to climate and landscape/resource change*." (Johnnie Moore, CALFED Lead Scientist).

This proposal describes a model-based approach for placing quantitative bounds on water resource and ecosystem responses to a plausible range of future changes in the BDRW system – critical information that will allow resource agencies to anticipate changes and develop flexibility in their strategic planning to accommodate those changes before they occur.

While this project has broad relevance to many goals of the CALFED Science Program, it is most directly relevant to the third priority research topic identified in the current PSP, which solicits "**analytical frameworks that will support assessments and refined predictions of how likely future changes such as population or climate-related hydrological shifts may affect water operations, ecosystem processes, and CALFED projects**".

The first product of this project will be a new approach linking climatic, hydrologic, hydrodynamic, biogeochemical, sediment/geomorphic, and biological models in a hierarchical manner to follow propagation of a prescribed signal (e.g. climate warming, levee failures) through cascading responses from the watershed, through the river system, and into the Delta and San Francisco Bay (Figs. 1 and 2). The coupling of models describing processes at different spatial scales (from global climate to Delta channels) provides an approach for viewing and exploring dynamics of the full system comprising the Delta, its watersheds, rivers, estuary, and coastal ocean. This approach will consolidate decades' worth of research findings from the project team's studies and data collection throughout the study area into a new and powerful capability for scenario evaluation to assist in strategic planning. The approach will provide a systems perspective for probing and understanding the interconnected components of the BDRW system. Modeling tools providing this perspective are essential for implementing ecosystem-based management, a guiding principle of the ERP: *"The Strategic Plan signals a fundamental shift in the way the ecological resources of the Bay-Delta ecosystem will be managed, because it embodies an ecosystem-based management approach with its attendant emphasis upon adaptive management. Traditional management of ecological resources has usually focused upon the needs of individual species. Ecosystem-based management, however, is a more integrated, systems approach that attempts to recover and protect multiple species by restoring or mimicking the natural physical processes that help create and maintain diverse and healthy habitats*." The models to be refined and linked in this project were selected to describe those processes that are key drivers of change in habitat and water quality and capacity of the BDRW system to sustain diverse native communities and ecosystem functions.

In addition to providing an analytical/modeling framework to assess likely implications of future changes, these tools will be applied to "**consider the effects of different combinations of changes… on Delta habitats and ecological processes**". Accordingly, the second product will be model-based projections describing how the Delta ecosystem might respond to the combined effects of climate and anthropogenic change. The projections will include consideration of the complex, nonlinear, and often surprising consequences of interconnected processes. They will be valuable for planning as quantitative depictions of how the Delta system might evolve over time, and because the contrast and comparison of multiple scenarios provides one measure of the likely range of plausible future outcomes.

The ERP Strategic Plan is built around the approach of adaptive management: "*Restoring and managing the Bay-Delta ecosystem requires a flexible management framework that can generate, incorporate, and respond to new information and changing Bay-Delta conditions. Adaptive management provides such flexibility and opportunities for enhancing our understanding of the ecosystem…".* A potentially valuable mode of adaptive management is to simulate long-term experiments with numerical models so that resource managers can anticipate and formulate adaptations to the changes hypothesized above. NOAA's assessment of climate-change effects on U.S. coastal ecosystems further highlights the relevance of our proposal: "*Regional scenarios of climate change are critical in understanding how local ecosystems will be affected, and might ultimately respond, to global change…. such knowledge will provide a foundation for resource managers and the public in developing adaptation strategies*" (Boesch et al. 2000). Our goal is a set of well-analyzed scenarios for those agencies tasked with restoring ecosystem functions, creating new habitats, and recovering populations in the Bay-Delta-River-Watershed.

A variety of priority study topics are identified in the current proposal solicitation. In addition to the study topics related to modeling frameworks for future change assessments, the outcomes of this interdisciplinary research project are relevant to several of the Science Program's other priority study topics:

- **Environmental Influences on Key Species and Ecosystems** – we will assess implications of habitat change (geomorphology, temperature, salinity, contaminants) for both key alien species and key native species of fishes in the Delta including salmonids and Delta smelt.
- **Relative Stresses on Key Fish Species:** We will assess potential changes in 1) ***food*** by evaluating changes in the system primary production and colonization by the alien bivalves that have outcompeted native zooplankton for the phytoplankton food resource; 2) ***contaminants*** with assessments of potential trends in the threats of mercury, selenium, silver and cadmium to both human health and living resources in the Delta and Bay; and 3) ***habitat*** by assessing change in the evolution of restored habitats with analysis of Bay-Delta sediment budgets and geomorphology, colonization by *Egeria* and alien bivalves, and seasonal patterns of river flow, water temperature and salinity distributions as key habitat attributes for species of concern.
- **Processes Controlling Delta Water Quality –** with model-based projections of salinity intrusion into the Delta under prescribed scenarios of river flow, sea level, levee failure and structural changes within the Delta.

Feasibility. The proposed study is ambitious but feasible because it is a natural extension of research performed by the project team over the past 5-25 years. It was designed to integrate results from recent studies conducted by the PI team, including CALFED-supported studies that have strengthened the scientific foundation of the ERP Strategic Plan. This prior work has contributed new knowledge and data on: hydroclimatology; energy supplies to Delta foodwebs; transports, transformations, and trophic transfer of contaminants; regional and local patterns of water circulation and mixing in the Delta; primary and secondary productivity; processes through

which invasive species disrupt ecosystem functions; and sedimentation in the Delta and Suisun and San Pablo Bays. Many of the conceptual and numerical models described in this proposal were developed in previous CALFED (and USGS) projects of integrated ecosystem science. Our objective here is to integrate these efforts, producing new knowledge and a scenario evaluation capability to assist in the long-range planning of CBDA agencies.

The experiments that make up this project will link process models and observations that span major elements of the BDRW system. Many key models and supporting data already exist, although the "models" range from numerical models to simplified conceptual descriptions of key processes. Key challenges will be to mesh the disparate spatial and temporal scales characterizing the various model inputs and outputs.

The project has been designed with realistic goals, specifically limiting the study's scope to a small, tractable number of scenarios that can be precisely articulated. The goal is to combine existing knowledge with a set of models to accurately assess ecosystem responses to several plausible scenarios of change in climate, sea level, within-Delta structures, and land use and population. Given the limits of current knowledge and the innovative nature of the modeling linkages required for thorough analyses of even a few scenarios, we are not promising to produce a turnkey modeling system. Rather, we will lay the groundwork for a future, more generalized modeling framework while addressing some key scenarios specified to meet pressing needs of the CBDA Science Program. A key part of our strategy, that ensures feasibility of the study, is that we have carefully chosen a wide-ranging study team with deep roots in the CBDA region, and focus on those system attributes that are within our individual areas of scientific expertise.

Furthermore, this project is not designed to anticipate change in water supply reliability and management adaptations to that change: this challenge is met by the Department of Water Resources through its evolving State Water Plan. Our project is designed as a complement to the State Water Plan, considering ecosystem-scale consequences of future change. Eventually, assessments and tools of even broader scope than we propose will be needed as California's climate and landscapes continue to change. The scope of our future efforts will grow as products are made available to scientists having other areas of expertise, but the proposed study will set a high standard for these future studies and modeling tools and will provide a firm basis for such additions. We are comfortable with the self-imposed limitations in project scope because we recognize this effort as an initial step, preparing for more comprehensive assessments of the future than can be developed in three years. Finally, this project is feasible because it combines resources supported by CALFED and the USGS. The total project cost is $3.48M, of which $1.64M will be provided by USGS through its Priority Ecosystems Program that has supported studies by this PI team over the past decade.

Dissemination of Results. Members of the study team have actively produced management-relevant research in the Bay-Delta system for the past several decades. From this experience, we know that the most relevant science comes when potential customers are involved at project inception. Planning for this project began with a workshop (the agenda from this workshop is available HERE) to solicit guidance about study design from the public and panelists. The assembled panel represented the U.S. Bureau of Reclamation, California Department of Water Resources, California Department of Fish and Game, Nature Conservancy, Metropolitan Water District, and Contra Costa Water District. In the audience were members of the U.S. EPA, California Department of Water Resources, State Water Resources Control Board, California Department of Fish of Game, USBR, NOAA Fisheries, California Department of Boating and Waterways, California Energy Commission, and the California Legislature, among others. The strongest message we heard from the ~100 attendees was concern that this is a USGS-only project seemingly disconnected from resource managers. In response to that criticism, the PIs have designed their studies as collaborations with resource agencies or academic scientists.

Letters of commitment/support are included (available HERE) from the U.S. Environmental Protection Agency, U.S. Bureau of Reclamation, California Department of Water Resources, U.S. Forest Service, San Francisco Estuary Institute, and faculty at University of California Davis, Berkeley, and San Diego. The breadth of this support reflects a tradition of USGS scientists working in partnership with Bay-Delta management and regulatory agencies and the academic community. This tradition reflects our conviction that scientific advancements have little value until they affect environmental policy. We are committed to working with the CALFED Science Program and Ecosystem Restoration Program to establish a mechanism for continuing dialogue, such as annual meetings with agency staffs, to present progress reports and receive feedback.

The study team will continue its well-documented tradition of presenting new results in the IEP Newsletter, San Francisco Estuary Project's *Estuary*, USGS Fact Sheets, *San Francisco Estuary and Watershed Science* and syntheses as CALFED-solicited white papers. We will present results at CALFED Science Conferences, State of the Estuary Conferences, IEP Annual Meetings, as briefings before CBDA science boards and the BDAC. We will continue to serve, when called, as members of advisory panels and working groups convened by CBDA and its agencies.

The study team has been publishing the website *Access USGS ─ San Francisco Bay and Delta* (http://sfbay.wr.usgs.gov/) since the mid-1990s, a site that now receives more than 70,000 visits per month. This site has been an invaluable resource for parties needing immediate access to data and research products from our ongoing scientific efforts in the Bay and Delta. We will continue our long reliance on the *Access USGS* site to provide, to public and technical audiences, information on modeling tools and results; the quantitative projections of climate, streamflows, population/land use changes, etc. that specify the scenarios; maps and animations (e.g., snow coverage, salinity intrusion, geomorphic change); posters; and quarterly progress reports. Other intermediate products, such as inputs for sediment and biological models, will be posted with metadata. Our existing bibliographic database will be updated annually and USGS reports and journal articles will be posted in PDF format. We will continue our dedication to making new scientific information easily accessible and understandable for a broad audience.

Work Schedule. Team members have planned to begin this project in January 2006 and complete it in December 2008. Timelines for the sequence of tasks of each element are shown in Figure 11.

Supplemental Information. Further information, including supporting figures, letters of support, and the agenda from the public planning workshop are available online: http://sfbay.wr.usgs.gov/access/CF_Scenarios/

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5. Figures

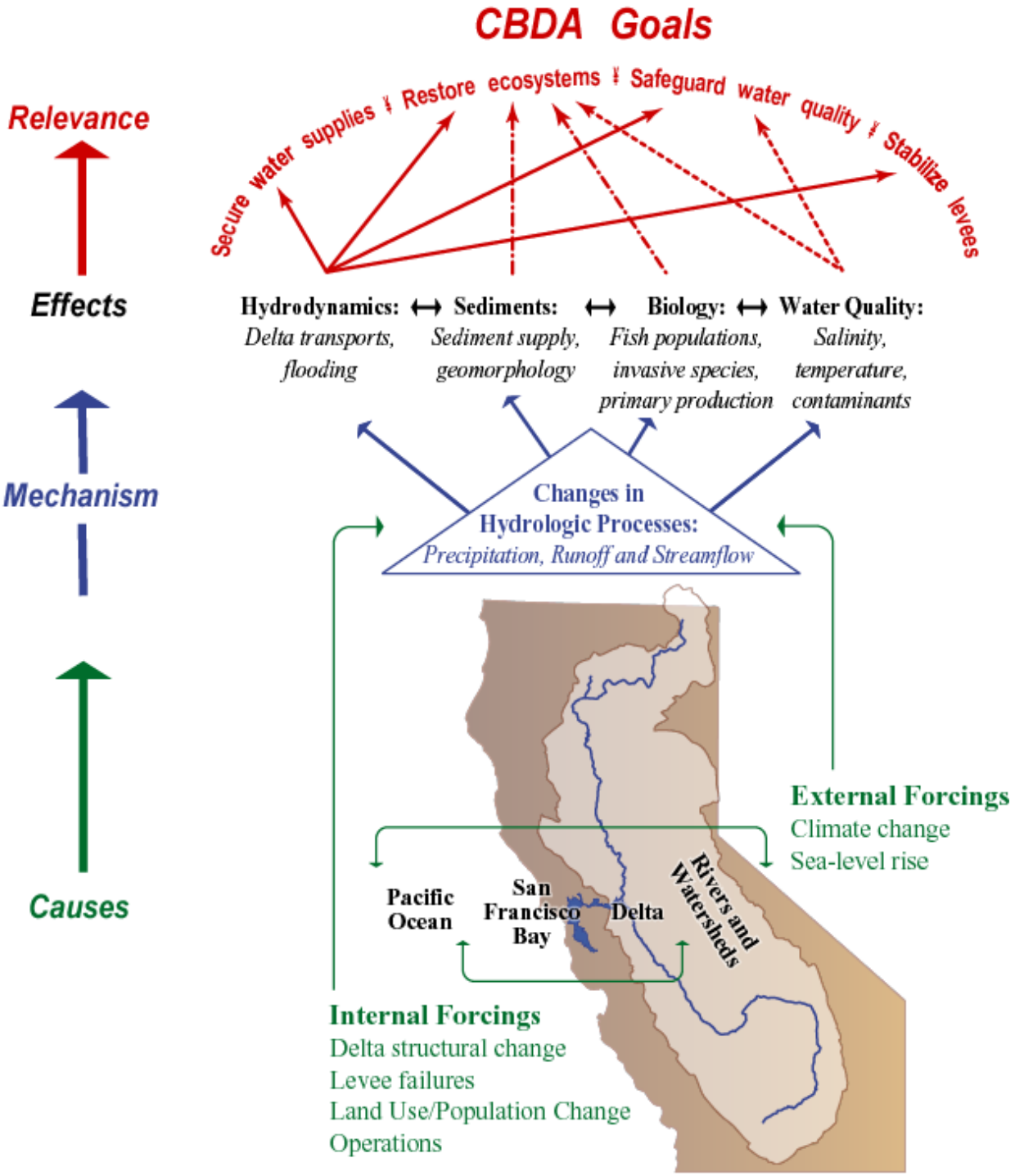

Figure 1. Conceptual model of external and internal forcings as drivers of change in hydrologic processes within the BDRW system, and of hydrologic change as the mechanism of cascading responses that include altered hydrodynamics and transports, sediment supplies and evolving geomorphology of the Bay and Delta, distributions of salinity and seasonal water temperature, loadings and bioaccumulation of toxic contaminants, and population responses of alien and native species including native fishes targeted for rehabilitation. The indicated connections between these complex cause-effect relationships and the four general goals of CBDA agencies will be addressed in this study.

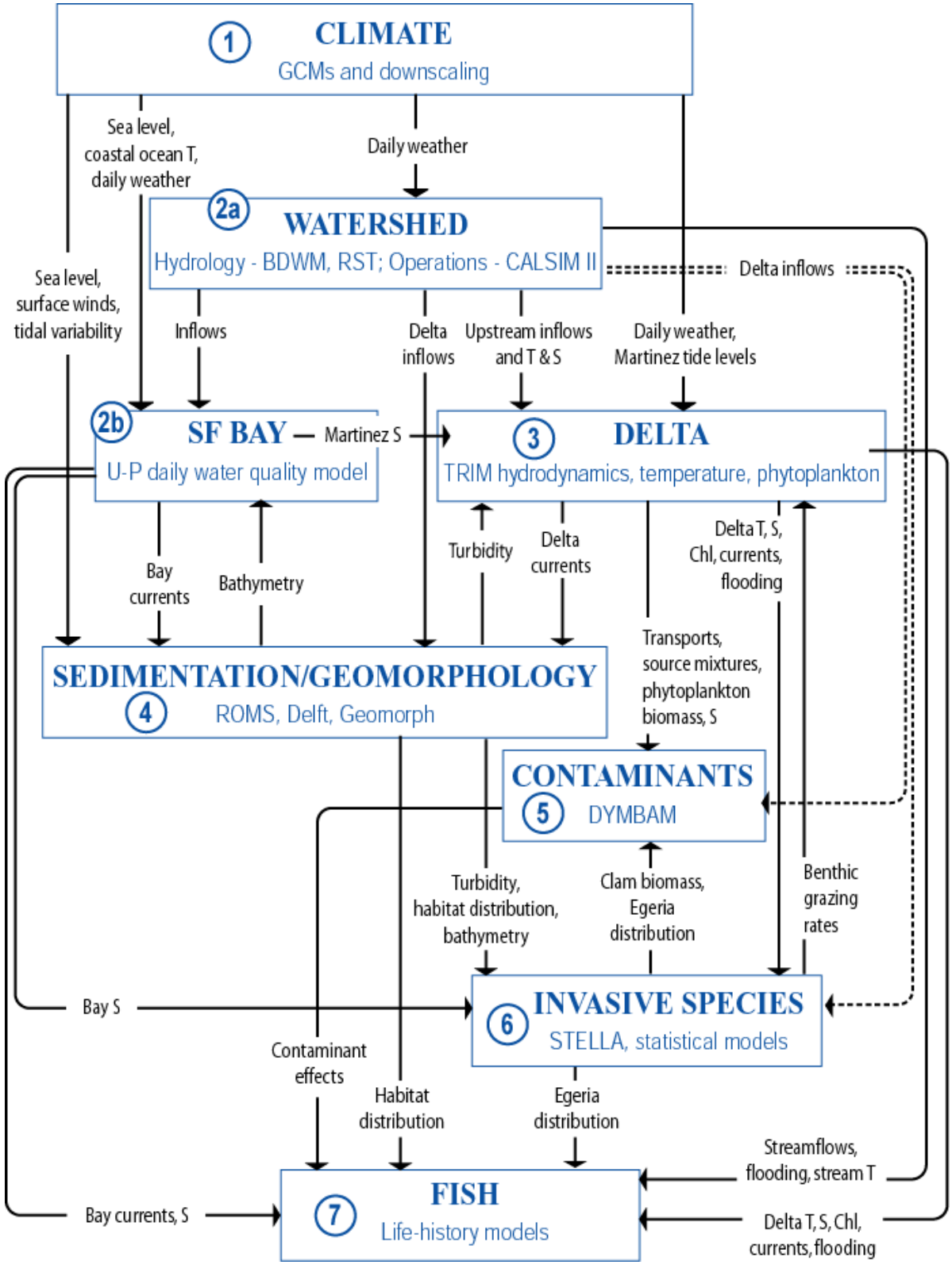

Figure 2. Data flow between project elements. To begin, scenarios of future climate will be produced by the climate element①; projected patterns of future land use and freshwater demand will be used to configure the hydrologic and operations models in ②**a**; and scenarios of Delta configuration change will be used to configure the models used in ③ and ④. Then, under a given scenario, each project element will use the indicated modeling approaches to provide data to other project elements, including, salinity (S), temperature (T), and chlorophyll (Chl). Cumulative model outputs will be synthesized into assessments of habitat quality change and potential population responses of native and alien species within the Delta.

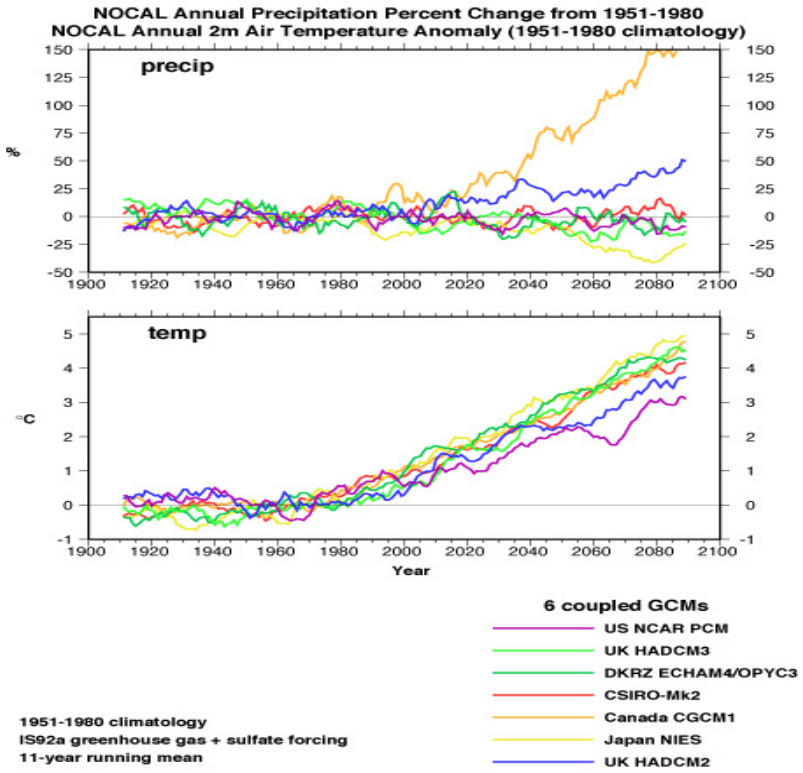

Figure 3. Comparisons of projected annual-mean changes in **top**: precipitation and **bottom:** surface-air temperatures over northern California in coupled global ocean-atmosphere climate models under estimated-historical and standard "business-as-usual" greenhouse-gas plus sulfate-aerosol emission scenarios for the 20th and 21st Centuries.

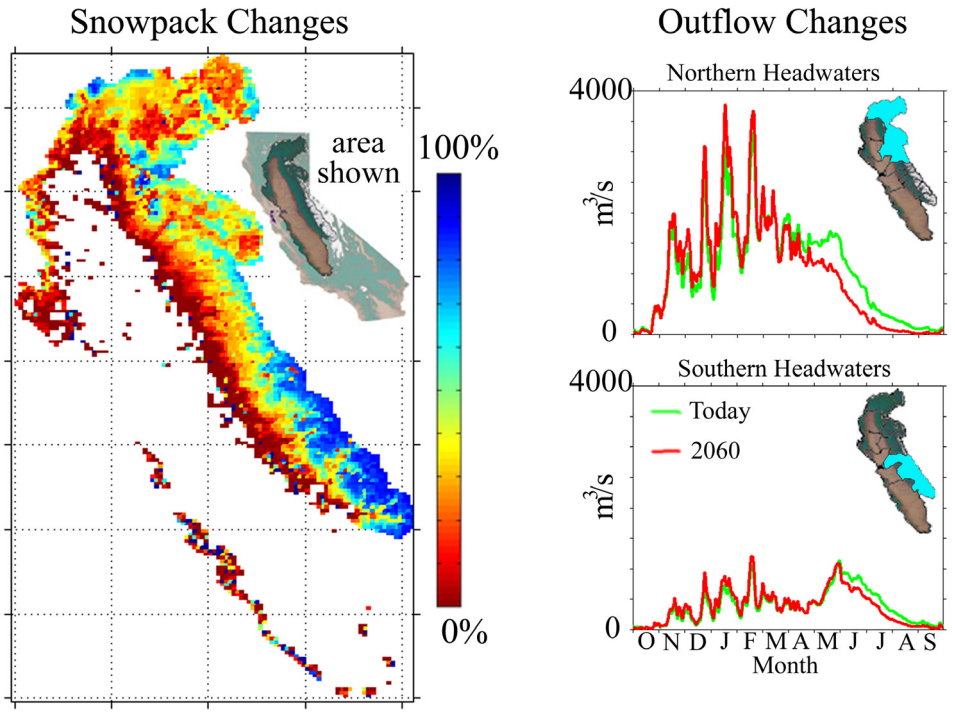

Figure 4. Projected remaining snowpack by 2060 (**left**) expressed as a percentage of present-day levels, and resulting changes in mean annual cycles of regional runoff (**right**). This is an application of the BDWM in which climate change projections were used to drive the model to assess potential hydrologic impacts by the year 2060. While the watershed's total snowpack volume is projected to diminish by one-third, most of this loss is focused in the moderate elevations of the northern Sierra and Cascade ranges, resulting in larger annual runoff changes in the North (Knowles and Cayan 2002).

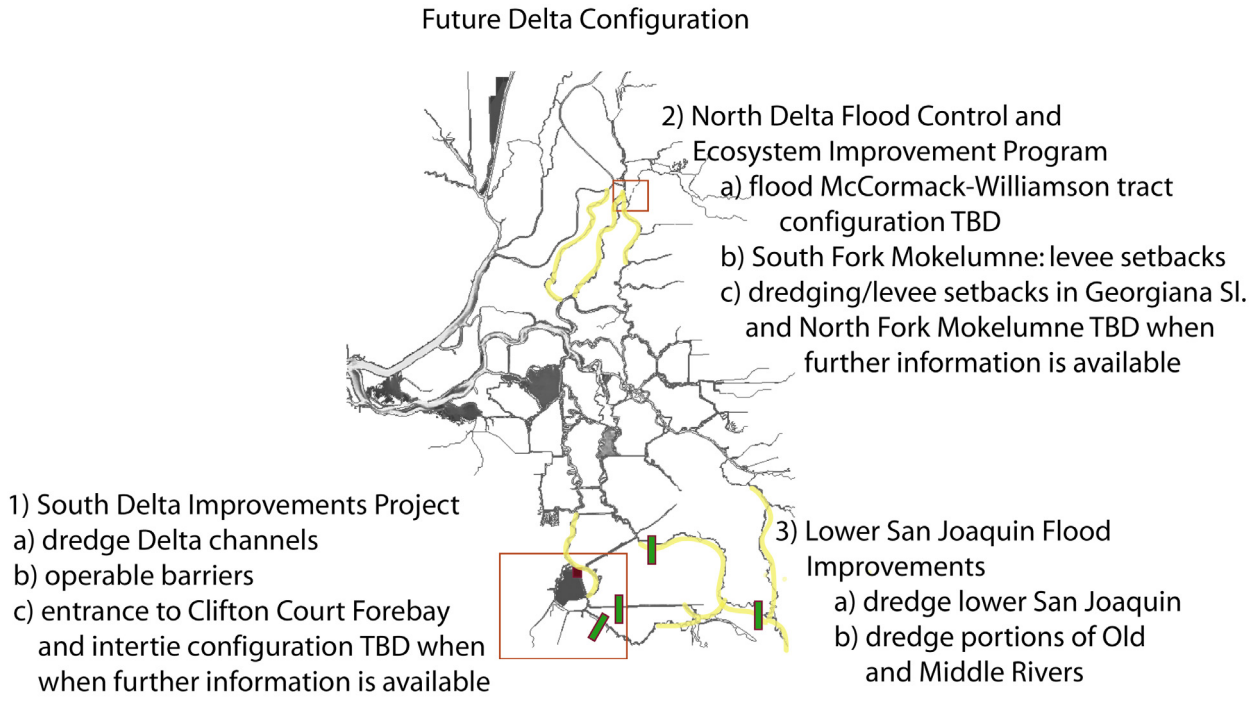

Figure 5. The scenario of change in the Delta's physical configuration, taken from the California Bay-Delta Program Conveyance Program Multi-Year Program Plan Years 5-8 (calwater.ca.gov/ProgramPlans_2004/Conveyance_Program_Plan_7-04.pdf). Three major projects will be included: a) South Delta Improvements Project, b) North Delta Flood Control and Ecosystem Improvement Program, and c) Lower San Joaquin River Flood Improvements. This configuration includes an intertie channel between the state (SWP) and federal (CVP) pumps, flooding of McCormack-Williamson tract, installation of south Delta barriers, and channel widening (or levee setbacks) on the Mokelumne, Georgiana Slough, San Joaquin R., Middle R., and Old R. Delta TRIM will be modified to represent this configuration. This suggested configuration might be altered based on additional information from the Delta Improvements Package Plan and the Delta Regional Ecosystem Restoration Implementation Plan (delta.dfg.ca.gov/erpdeltaplan/), once these documents are available in their final form.

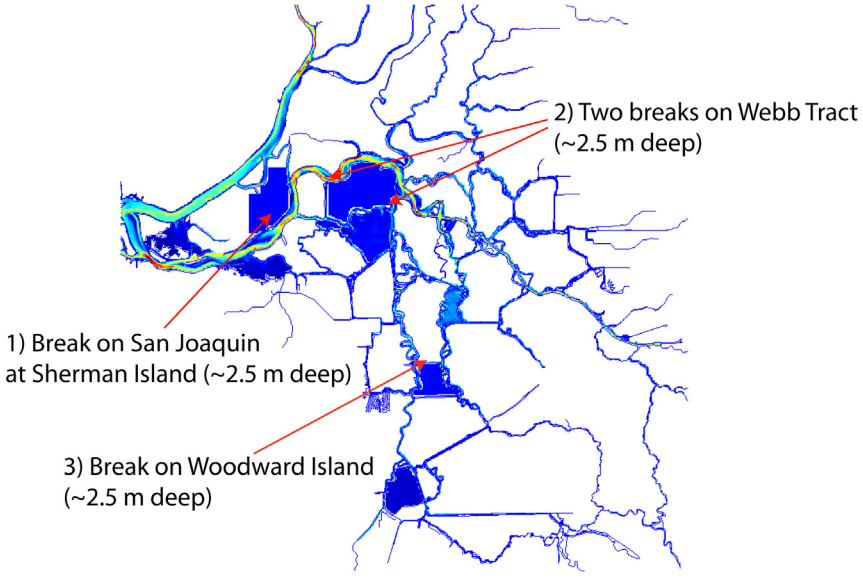

Figure 6. The scenario of catastrophic levee failure in the Delta, prescribed as flooding (to a depth of ~2.5 m) in Sherman Island, Webb Tract and Woodward Island. This scenario is based on levees recently repaired (Kurosaka talk 2/6/2004) and the CALFED Levee System Integrity Program Plan (calwater.ca.gov/Programs/LeveeSystemIntegrity/LeveeSystemProgramPlan.shtml)

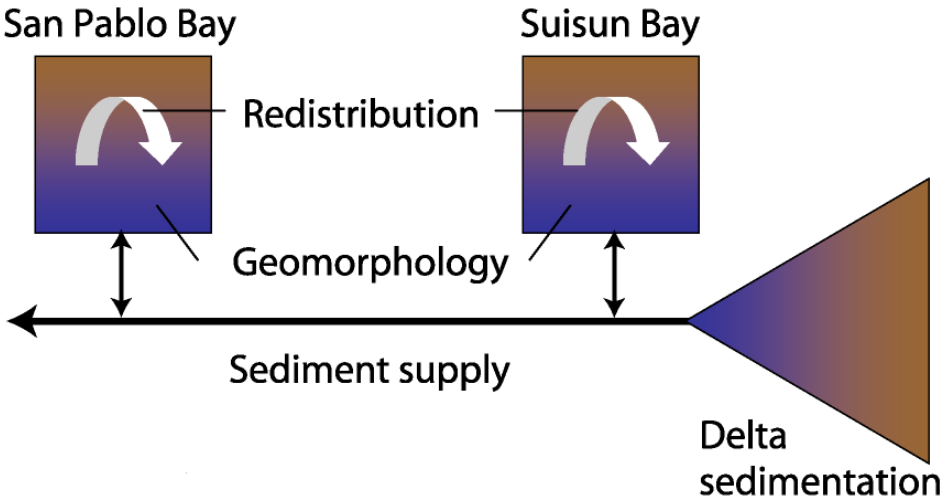

Figure 7. Linked models of geomorphic evolution. Delta sedimentation model will extrapolate recently collected sediment load data; and route suspended sediment load through main conduits. Sedimentation within Delta channels will be estimated, and export from the Delta is routed to the Bay. Sediment supply from the Delta will be delivered to Suisun Bay using available 1-D, 2-D and 3-D models, followed by redistribution modeling within Suisun Bay. The subsequent export to San Pablo Bay can then be distributed within San Pablo Bay using 3-D modeling techniques, followed by the ultimate export of sediment out of the Bay/Delta system. Net geomorphic change in each subembayment will be the final result, estimating the distribution of diverse habitat (i.e. channel, mudflat, marsh).

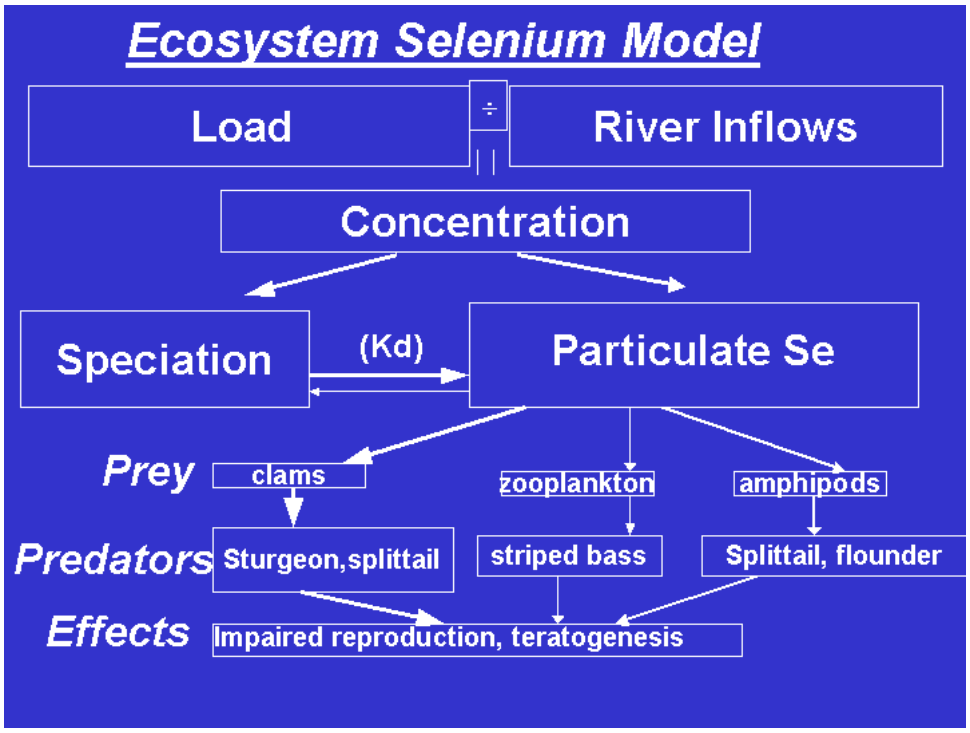

Figure 8. Pollutant effects in San Francisco Bay are tied in complex and interactive ways to hydrology, hydrodynamics, sediment transport, ecological processes and food web structure (e.g. Brown *et al.* 2003; Luoma *et al.* 1985; Luoma and Presser 2000; Stewart *et al.* 2004). The approach outlined above will be extended to include other contaminants as described in ⑤.

Parameter	Dependencies	Literature Citation or Data Source
Egeria densa		
Salinity limit	<5 psu maintenance <8psu survival	Hauenstein & Ramirez 1986
Temperature limit	28˚ C limits; <16 & >32˚ C poor growth	Barko &Smart 1981
Depth limit	<3.5 m	Romberg Tiburon Web, personal observation
Velocity limit	<1 m/s	Chambers et al 1991
Corbicula fluminea		
Growth Rate	Function of temperature/food	Foe and Knight 1985, Foe et al. 2002
Mortality Rate	TBD (1977-2003)	DWR
Fecundity	Function of weight/food	McMahon 1999
Recruitment	TBD (1977-2003)	DWR
Immigration	TBD (1977-2003)	DWR, USGS (2002 only)
Distribution	Salinity, temperature, velocity, substrate	McMahon 1999
Potamocorbula amurensis		
Growth Rate	TBD (1988-2003)	USGS, DWR, Thompson 2004
Mortality Rate	TBD (1988-2003)	USGS, DWR, Thompson 2004
Fecundity	Function of size/weight	From congener; Wei and Guan 1986
Recruitment	TBD (1988-2003)	USGS, DWR, Parchaso & Thompson 2002, Nicolini & Penry 2000
Immigration	TBD (1988-2003)	USGS, DWR
Distribution	Salinity, temperature, substrate	USGS, DWR, Clark et al. 2000

Figure 9. Source for life history parameters for Egeria, Corbicula, and Potamocorbula to be used in statistical and STELLA models. (*TBD to be determined from field data during study with data years in parentheses)

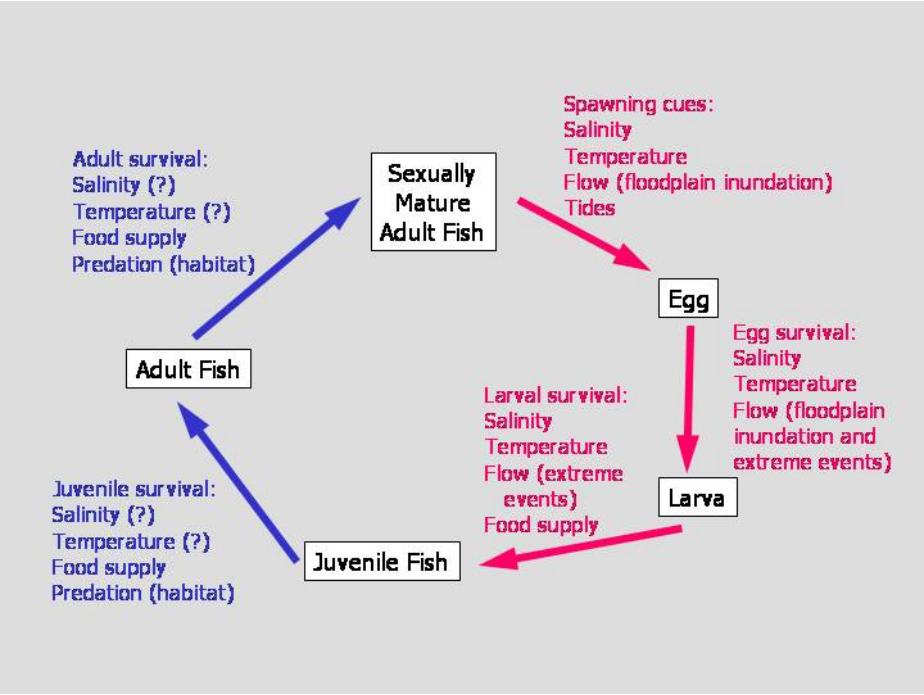

Figure 10. A hypothetical example of a life-cycle model for a fish species of interest. In this example, environmental effects are assumed to be most critical from adult spawning to juvenile recruitment (red). Juvenile and adult stages (blue) are usually more tolerant of environmental extremes and are more mobile, allowing them to move out of unfavorable areas.

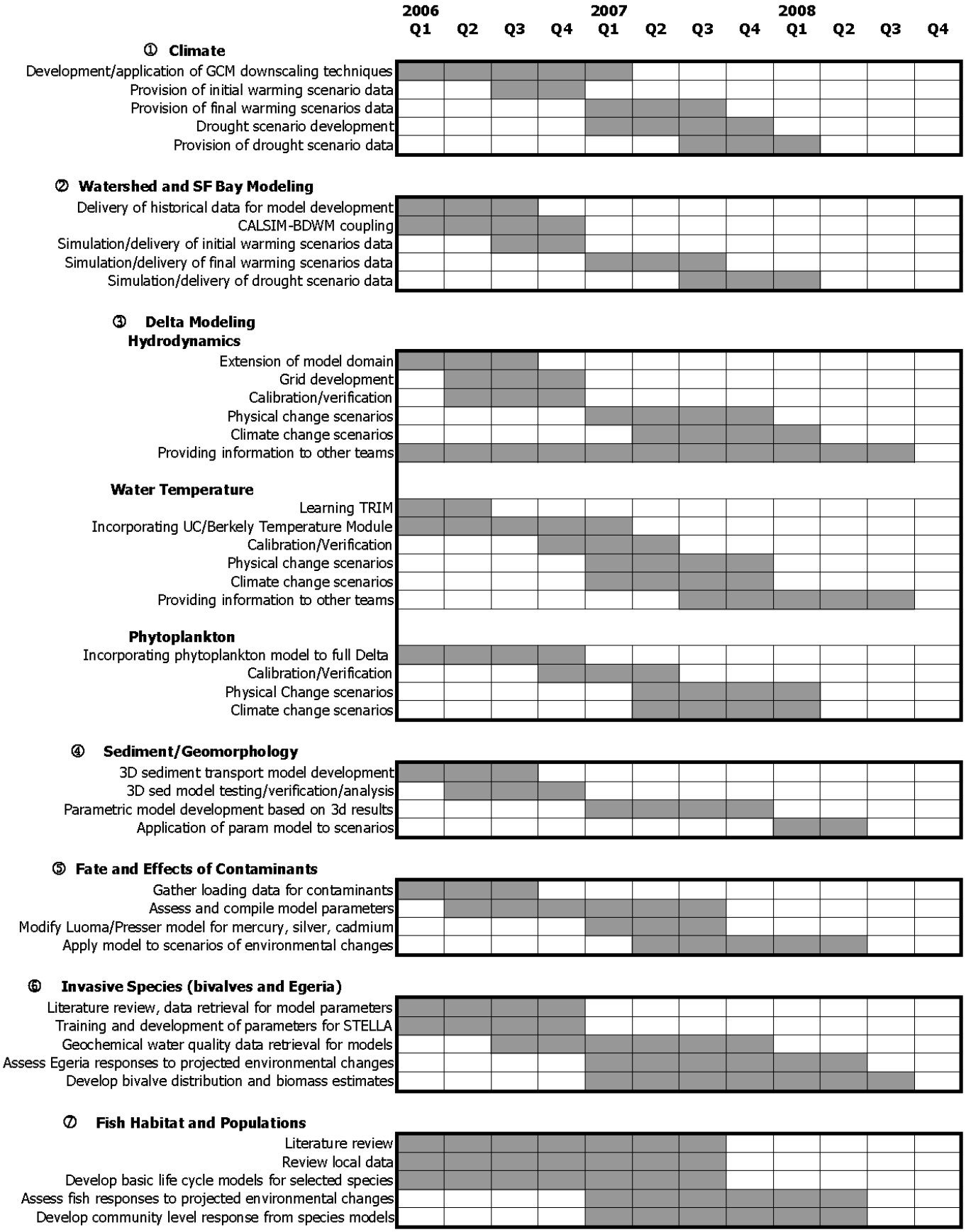

Figure 11. Timelines showing the progression of tasks for each element of a three-year research project to assess responses of the Bay-Delta-River-Watershed system to scenarios of 21st century change. All elements will perform analysis and reporting (not shown) during the project's 3rd year.

BIOGRAPHICAL SKETCH - JAMES E. CLOERN

EDUCATION

University of Wisconsin-Madison, B.S. 1970, Zoology
University of Wisconsin-Milwaukee, M.S. 1973, Zoology
Washington State University, Ph.D. 1976, Zoology

RESEARCH AND PROFESSIONAL EXPERIENCE

1999-present	Senior Research Scientist (ST3104), U.S. Geological Survey
1976-1999	Research Scientist, U.S. Geological Survey, Menlo Park, CA
1997-1998	Lecturer, University of California-Santa Cruz, Department of Earth Sciences
1997-present	Consulting Professor, Stanford University, Department of Civil Engineering
1993	Distinguished Visiting Scientist, National Institute of Water and Atmospheric Research, Hamilton, New Zealand
1993-1994	Directeur de Recherche, Université d'Aix-Marseille, France
1974-1976	Teaching Assistant, Washington State University.
1972-1973	Teaching Assistant, University of Wisconsin-Milwaukee

RESEARCH INTERESTS

Ecology and biogeochemistry of aquatic ecosystems, focused around a long term (28-year) investigation of San Francisco Bay that has included study of: primary production, algal and zooplankton community dynamics, plankton diversity, net ecosystem metabolism, carbon budgets, resource limitation of algal growth, grazing by benthic suspension feeders, disturbance by introduced species, impacts of climatic/hydrologic variability, mechanisms and biogeochemical significance of algal blooms, benthic and pelagic nutrient regeneration, stable isotopes and lipid biomarkers to characterize sources of organic matter, coastal eutrophication, and ecosystem variability at time scales from hours to decades and spatial scales from thin layers to watersheds.

HIGHLIGHTS

Associate Editor, *Limnology and Oceanography*, 2004-

Golden Screen Award, National Association of Government Communicators, for the documentary "Delta Revival: Restoration of a California Ecosystem", 2003

U.S. Department of Interior Distinguished Service Award, 2000

U.S. Federal Senior Scientist ST3104, 1999

Steering Committee, 1997 Aquatic Sciences Meeting, Santa Fe

Fulbright Research Scholar, 1993-94 (Centre d'Océanologie de Marseille)

U.S. Department of Interior Meritorious Service Award, 1991

Editorial Board, *Limnology and Oceanography*, 1989-1992

Associate Editor, *Estuaries*, 1989-1994

Associate Editor, *Oceanologica Acta*, 1999-present

Program Chair, 1991 Estuarine Research Federation Meeting, San Francisco

Member, Science Advisory Committees: (examples) Florida Bay Program, San Francisco Bay-Delta Interagency Ecological Program, Bay of Brest Program (France), USEPA Eagles Program on Estuarine Indicators, Tampa Bay Program, CALFED Environmental Water Account

Postdoctorates: Dr. Linda Huzzey, Dr. Richard Miller, Dr. Jane Caffrey, Dr. Joseph Rudek, Dr. Elizabeth Canuel, Dr.Lisa Lucas (2003 recipient of ERF's Eugene Cronin Young Investigator Award), Dr. William Sobczak (2004 recipient of ASLO's Raymond Lindeman Award), Dr. Jean-Marc Guarini, Dr. Laurent Chauvaud, Dr. Nancy Monsen

PEER-REVIEWED PUBLICATIONS SINCE 1995

Cloern, J.E. and Jassby, A.D., 1995, Yearly fluctuation of the spring phytoplankton bloom in South San Francisco Bay: An example of ecological variability at the land-sea interface, in Steele, J.H, Powell, T.M., and Levin, S., eds., Ecological Time Series, Chapman Hall, p. 139-149.

Canuel, E.A., Cloern, J.E., Ringelberg, D., Guckert, J., and Rau, G., 1995, Molecular and isotopic tracers used to understand sources of organic matter and trophic relationships in the San Francisco Bay estuary: Limnology and Oceanography, v. 40, p. 67-81.

Jassby, A.D., Kimmerer, W.J., Monismith, S., Armor, C., Cloern, J.E., Powell, T.M., Schubel, J.R., and Vendlinski, T. 1995, Isohaline position as a habitat indicator for estuarine resources: San Francisco Bay-Delta, California, U.S.A.: Ecological Applications, v. 5, pp. 272-289.

Cloern, J.E., Grenz, C., and Vidergar-Lucas, L., 1995. An empirical model of the phytoplankton chlorophyll/carbon ratio -- the conversion factor between productivity and growth rate: Limnology and Oceanography, v. 40, p. 1313-1321.

Canuel, E.A., and Cloern, J.E., 1996, Regional differences in the origins of organic matter in the San Francisco Bay ecosystem. Evidence from lipid biomarkers, in J.T. Hollibaugh, editor, San Francisco Bay: The Ecosystem, Pacific Division, AAAS, San Francisco, p. 305-324.

Rudek, J., and Cloern, J.E., 1996, Planktonic respiration rates in San Francisco Bay, in J.T. Hollibaugh, editor, San Francisco Bay: The Ecosystem, Pacific Division, AAAS, San Francisco, p. 289-304.

Cloern, J.E., 1996. Phytoplankton bloom dynamics in coastal ecosystems: A review with some general lessons from sustained investigation of San Francisco Bay, California. Reviews of Geophysics, Vol. 34 , No. 2 , p. 127-168.

Cole, B.E., Cloern, J.E., and Alpine, A.E., 1997, The photosynthetic response of phytoplankton in Shingobee Lake and Williams Lake: USGS Water-Resources Investigations Report 96-4215, pages 105-110.

Cloern, J.E., Alpine, A.E., and Cole, B.E., 1997, Seasonal comparisons of seston abundance and sedimentation rate in a closed-basin lake (Williams) and an open-basin lake (Shingobee): USGS Water-Resources Investigations Report 96-4215, pages 111-117.

Jassby, A.D., Cole, B.E., and Cloern, J.E., 1997. The design of sampling transects for characterizing water quality in estuaries: Estuarine, Coastal and Shelf Science, v. 45: 285-302.

Luoma, S.N., van Geen, A., Lee, B.-G., and Cloern, J.E., 1998, Metal uptake by phytoplankton during a bloom in South San Francisco Bay: Implications for metal cycling in estuaries: Limnology and Oceanography, v. 43, pp. 1007-1016.

Lucas, L, J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson, 1998, Does the Sverdrup Critical Depth Model explain bloom dynamics in estuaries? Journal of Marine Research, v. 56: 1-41.

Cloern, J.E. 1998. Book Review: "Eutrophication in Coastal Marine Ecosystems", Jørgensen, B.B. and K. Richardson [Eds.]. Limnology and Oceanography, v. 43, pp. 1018-1019.

Caffrey, J.M., C. Grenz, and J.E. Cloern, 1998. Changes in production and respiration during a spring phytoplankton bloom in San Francisco Bay, California: implications for net ecosystem metabolism. Marine Ecology Progress Series 172:1-12.

Cloern, J.E. 1999. The Relative Importance of Light and Nutrient Limitation of Phytoplankton Growth: A Simple Index of Coastal Ecosystem Sensitivity to Nutrient Enrichment: Aquatic Ecology 33: 3-15.

Lucas, L.V., J.R. Koseff, J.E. Cloern, S.G. Monismith and J.K. Thompson. 1999. Processes governing phytoplankton blooms in estuaries. Part I. The local production-loss balance. Marine Ecology Progress Series 187:1-15.

Lucas, L.V., J.R. Koseff, J.E. Cloern, S.G. Monismith and J.K. Thompson. 1999. Processes governing phytoplankton blooms in estuaries. Part II. The role of transport in global dynamics. Marine Ecology Progress Series 187: 17-30.

Grenz C., Cloern J.E., Hager S.W., Cole B.E. 2000. Dynamics of nutrient cycling and related benthic nutrient and oxygen fluxes during a spring phytoplankton bloom in South San Francisco Bay (USA). Marine Ecology Progress Series 197: 67-80

Ning, X., Cloern, J.E., and Cole, B.E. 2000. Spatial and temporal variability of picocyanobacteria *Synechococcus* sp. in San Francisco Bay. Limnology and Oceanography 45: 695-702.

Jassby, A.D. and J.E. Cloern. 2000. Organic matter sources and rehabilitation of the Sacramento-San Joaquin Delta (California, USA). Aquatic Conservation: Marine and Freshwater Ecosystems 10: 323-352.

Howarth, R., D. Anderson, J. Cloern, C. Hopkinson, B. LaPointe, T. Malone, N. Marcus, K. McGlathery, and A. Sharpley. 2000. Nutrient Pollution of Coastal Rivers, Bays, and Seas. Issues in Ecology 7:1-15.

Cloern, J.E. 2001. Our evolving conceptual model of the coastal eutrophication problem. Marine Ecology Progress Series 211: 223-253.

Cloern, J.E., E.A. Canuel, D. Harris. 2002. Stable carbon and nitrogen isotope composition of aquatic and terrestrial plants of the San Francisco Bay estuarine system. Limnology and Oceanography 47: 713-729.

Jassby, A.D., J.E. Cloern, B.E. Cole. 2002. Annual primary production: patterns and mechanisms of change in a nutrient-rich tidal ecosystem. Limnology and Oceanography 47: 698-712.

Guarini, J.-M., J.E. Cloern, J. Edmunds, P. Gros. 2002. Microphytobenthic potential productivity estimated in three tidal embayments of the San Francisco Bay: A comparative study. Estuaries 25: 409-417.

Lucas, L.V., J.E. Cloern, J.K. Thompson, N.E. Monsen. 2002. Functional variability of habitats within the Sacramento-San Joaquin Delta: restoration implications . Ecological Applications 12: 1528-1547.

Lucas, L.V. and J.E. Cloern. 2002. Effects of tidal shallowing and deepening on phytoplankton production dynamics: a modeling study. Estuaries 25: 497-507.

Sobczak, W.S., Cloern, J.E., Jassby, A.D and Mueller-Solger, A. 2002. Bioavailability of organic matter in a highly disturbed estuary. The role of detrital and algal resources. Proceedings of the National Academy of Sciences 99: 8101-8105.

Monsen, N.E., Cloern, J.E., Lucas, L.V., and Monismith, S.G. 2002. A comment on the use of flushing rate, residence time and age as transport time scales. Limnology and Oceanography 47: 1545-1553.

Chauvaud, L., Thompson, J.K., Cloern, J.E. and Thouzeau, G. 20023. Clams as CO_2 generators: The Potamocorbula amurensis example in San Francisco Bay. Limnology and Oceanography 48: 2086-2092.

Jassby, A.D., J.E. Cloern, A. Mueller-Solger. 2003. Phytoplankton fuels the food web in Delta waterways. California Agriculture 57:104-109.

May, C.L., J.R. Koseff, L.V. Lucas, J.E. Cloern, and D.H. Schoellhamer. 2003. Effects of spatial and temporal variability of turbidity on phytoplankton blooms. Marine Ecology Progress Series 254: 111-128.

Cloern, J.E., T.S. Schraga, C.B. Lopez, R. Labiosa. 2003. Lessons from monitoring water quality in San Francisco Bay. In 2003 Pulse of the Estuary, San Francisco Estuary Institute, pp. 15-20.

Cloern, J.E. Phytoplankton community ecology: principles applied in San Francisco Bay. 2004. Marine Ecology Progress Series, in press.

Chauvaud, L., J.-M. Guarini, Y.-M. Paulet, G. Thouzeau and J.E. Cloern. 2004. Modelling the shell growth of scallops (Pecten maximus) as an intermittent non-steady-sate process. Journal of Experimental Marine Biology and Ecology, in press.

Sobczak, W.V., J.E. Cloern, A.D. Jassby, B.E. Cole, T.S. Schraga, and A. Arnsberg. 2004. Detritus fuels ecosystem metabolism but not metazoan foodwebs in San Francisco Estuary's freshwater Delta. Estuaries. In press.

Manuscripts in Review:

Monsen, N.E., J.E. Cloern, J.R. Burau. Water diversion as an ecosystem disturbance: examples from the Sacramento-San Joaquin River Delta (California). Submitted to Water Resources Research

Burns Lopez, C., J.E. Cloern, T.S. Schraga, A.J. Little, L.V. Lucas. Ecological values of shallow-water habitats: implications for restoration of a highly disturbed ecosystem. Submitted to Ecosystems

BIOGRAPHICAL SKETCH: LARRY R. BROWN

EDUCATION:

University of California-Irvine, B.S., 1978, Biological Sciences
University of California-Davis, B.S., 1980, Wildlife and Fisheries Biology
University of California-Davis, M.S., 1982, Ecology
University of California-Davis, Ph.D., 1988, Ecology

RESEARCH AND PROFESSIONAL EXPERIENCE:

1999-present	Research Biologist, U.S. Geological Survey, Sacramento, CA
1997-1999	Fishery Biologist, U.S. Bureau of Reclamation, Sacramento, CA. This was a two-year temporary assignment from the U.S. Geological Survey.
1991-1997	Physical Scientist, U.S. Geological Survey, Sacramento, CA.
1991	Lecturer, Dept. Marine Sciences, University of California, Santa Cruz, CA.
1987-1991	Post-graduate Researcher, University of California, Davis, CA.
1980-1987	Research Assistant, University of California, Davis, CA.
1984-1985	Teaching Assistant, University of California, Davis, CA.
1980	Teaching Assistant, University of California, Davis, CA.

RESEARCH INTERESTS:

My research interests include the ecology of aquatic communities, the associations of such communities with environmental conditions, and invasion ecology, focusing on the environmental factors associated with the success of invading species and their interactions with native communities. I have been particularly interested in predation and the effects of introduced predators on native organisms. I have over 20 years experience working in California aquatic systems, primarily streams, rivers, and the Sacramento-San Joaquin Delta. I am a recognized expert on the ecology of California fishes and, since starting work with the U.S. Geological Survey, have gained considerable experience with benthic macroinvertebrates and algae.

PROFESSIONAL ACTIVITIES AND HIGHLIGHTS:

Symposium organizer, 2003 American Fisheries Society Annual Meeting, Effects of Urbanization on Aquatic Ecosystems, 2003
Co-Editor of American Fisheries Society Symposium volume (in progress), Effects of Urbanization on Aquatic Ecosystems, 2003-present
Co-Editor of American Fisheries Society Symposium volume, Early Life History of Fishes in the San Francisco Estuary and Watershed, 2002-2004
Co-Program Chair for the 2nd CALFED Science Conference, 2002-2003
Screening panel member for selection of candidates for National Marine Fisheries Service Recovery Teams for Central Valley salmonids (2002) and coho salmon (2002)
President, Water Quality Section, American Fisheries Society, 2001-2003
President, California-Nevada Chapter, American Fisheries Society, 2001-2002
Selection Committee, EPA Science Achievement Award, Biology/Ecology, 2000 and 2001

Co-Program Chair, for the 1st CALFED Science Conference, 2000,
Session Chair, Annual Meeting, California-Nevada Chapter, American Fisheries Society, 1999 and 2000
U.S. Bureau of Reclamation Performance Award, 1999
American Fisheries Society, Certified Fisheries Biologist, 1997-present
U.S. Fish and Wildlife Service Certificate of Appreciation (for membership on the Delta Native Fishes Recovery Team), 1995
U.S. Geological Survey Performance Awards, 1992-1994
Academic Committees: Joaquin B. Feliciano, University of California-Davis (in progress); Dr. Joe Merz, University of California-Davis; Dr. Robert Leidy, University of California-Davis
Referee for various journals including: Transactions of the American Fisheries Society, Environmental Biology of Fishes, Canadian Journal of Fisheries and Aquatic Sciences, North American Journal of Fisheries Management, Copeia, and Archives of Environmental Contamination and Toxicology

PEER-REVIEWED PUBLICATIONS (LAST 10 YEARS):

Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Status of coho salmon (*Oncorhynchus kisutch*) in California. North American Journal of Fisheries Management 14:237-261.

Brown, L.R., S.A. Matern, and P.B. Moyle. 1995. Comparative ecology of prickly sculpin (*Cottus asper*) and coastrange sculpin (*C. aleuticus*) in the Eel River drainage, California. Environmental Biology of Fishes 42:329-343.

Brown, L.R. and A. Brasher. 1995. Effects of predation by Sacramento squawfish (*Ptychocheilus grandis*) on habitat choice of California roach (*Lavinia symmetricus*) and rainbow trout (*Oncorhynchus mykiss*) in artificial streams. Canadian Journal of Fisheries and Aquatic Sciences 52:1639-1646.

Periera, W.E., Domagalski, J.L., Hostettler, F.D., Brown, L.R., and Rapp, J.B. 1996. Occurrence and accumulation of pesticides and organic contaminants in river sediment, water and clam tissues from the San Joaquin River and tributaries, California. Environmental Toxicology and Chemistry 14:172-180.

Brown, L.R. 1997. Water-quality assessment of the San Joaquin-Tulare basins, California: Analysis of available information on aquatic biology, through 1992. U.S. Geological Survey, Water Supply Paper 2471.

Brown, L.R. and P.B. Moyle. 1997. Invading species in the Eel River, California: successes, failures, and relationships with resident species. Environmental Biology of Fishes 49:271-291.

Brown, L.R. 1997. Concentrations of chlorinated organic compounds in biota in relation to concentrations in bed sediment in streams of the San Joaquin Valley, California. Archives of Environmental Contamination and Toxicology 33:357-368.

Brown, L.R., C.R. Kratzer, and N.M. Dubrovsky. 1999. Integrating chemical, water quality, habitat, and fish assemblage data from the San Joaquin River drainage, California. Pp. 25-62, in, K.M. Scow, G.E. Fogg, D.E. Hinton, and M.L. Johnson (eds.), Integrated assessment of ecosystem health, Lewis Publishers, Boca Raton, FL.

Brown, L.R., A.M. Brasher, B.C. Harvey, and M. Matthews. 1999. Success and failure of invading species in stream systems: case studies from California and Hawaii. Pp. 415-430, in, R. Claudi and J. Leach (eds.), Non-indigenous freshwater organisms in North

America: their biology and impact, Lewis Publishers, Boca Raton, FL.
Brown, L.R. 2000. Fish communities and their associations with environmental variables, lower San Joaquin River drainage, California. Environmental Biology of Fishes 57:251-269.
Brown, L.R. and J.T. May. 2000. Macroinvertebrate assemblages on woody debris and their relations with environmental variables in the lower Sacramento and San Joaquin river drainages, California. Environmental Monitoring and Assessment. Environmental Monitoring and Assessment 64:311-329.
Ford, T.J. and L.R. Brown. 2001. Distribution and Abundance of Chinook Salmon and Resident Fishes of the Lower Tuolumne River, California. Pp. 253-304, in, R. Brown (ed.), Fish Bulletin 179: Contributions to the Biology of Central Valley Salmonids. California Department of Fish and Game, Sacramento, CA.
Leland, H.V., L.R. Brown, and D.K. Mueller. 2001. Distribution of algae in the San Joaquin River, California, in relation to nutrient supply, salinity, and other environmental factors. Freshwater Biology 46:1139-1167.
May, J.T. and L.R. Brown. 2002. Fish community structure in relation to environmental variation within the Sacramento River Basin and implications for streams of the Central Valley, California. Environmental Biology of Fishes 63:373-388.
Brown, L.R. and T.J. Ford. 2002. Effects of flow on the fish communities of a regulated California river: implications for managing native fishes. River Research and Applications 18:331-342.
Meador, M.R., L.R. Brown, and T.M. Short. 2003. Relations between introduced fish and environmental conditions at large geographic scales. Ecological Indicators 3:81-92.
Brown, L.R. 2003. An introduction to the San Francisco Estuary tidal wetlands restoration series. In: L.R. Brown, editor. Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science. Vol. 1, Issue 1, Article 1. http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art1.
Brown, L.R. 2003. Will tidal wetland restoration enhance populations of native fishes? In: L.R. Brown, editor. Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science. Vol. 1, Issue 1, Article 2. http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art2.
Brown, L.R. 2003. Potential effects of organic carbon production on ecosystems and drinking water. In: L.R. Brown, editor. Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science. Vol. 1, Issue 1, Article 3. http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art3.
Brown, L.R. 2003. A summary of the tidal wetlands restoration series. In: L.R. Brown, editor. Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science. Vol. 1, Issue 1, Article 6. http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art6.
Dege, M. and L.R. Brown. 2004. Springtime Distribution and Abundance of Larval and Juvenile Fishes in the Upper San Francisco Estuary. Pages 49-66 *in* F. Feyrer, L.R. Brown, R. Brown, and J. Orsii, editors. Early Life History of Fishes in the San Francisco Estuary and Watershed. American Fisheries Society.
Matern, S.A. and L.R. Brown. In press. Invaders eating invaders: exploitation of novel alien prey by the shimofuri goby in the San Francisco Estuary, California. Biological Invasions.
Brown, L.R. and P.B. Moyle. In press. Native fish communities of the Sacramento-San Joaquin watershed, California: a history of decline. Pages XX *in* F. Rinne, R. Hughes, and R.

Calamusso, editors. Fish Communities of Large Rivers of the United States. American Fisheries Society.

Burton, C.A., L.R. Brown, and K. Belitz. In press. Relations of water source and channel type with benthic macroinvertebrate and periphyton communities in the highly urbanized Santa Ana River Basin, California. American Fisheries Society Symposium Volume, Effects of Urbanization on Stream Ecosystems.

Brown, L.R., C.A. Burton, and K. Belitz. In press. Aquatic communities of the highly urbanized Santa Ana River Basin, California. American Fisheries Society Symposium Volume, Effects of Urbanization on Stream Ecosystems.

MANUSCRIPTS IN REVIEW:

Brown, L.R. and D. Michniuk. Nearshore fish assemblages of the alien-dominated Sacramento-San Joaquin Delta,1980-1983 and 2001-2003. Submitted to Transactions of the American Fisheries Society.

Giddings, E., L.R. Brown, T. M. Short, and M.R. Meador. Relation of fish communities to environmental conditions in urban streams of the Wasatch Front, Utah. Submitted to Western North American Naturalist.

Giddings, E., L.R. Brown, T. M. Short, and M.R. Meador. Brown trout condition as an indicator of environmental stress in urban streams of the Wasatch Front, Utah. Submitted to North American Journal of Fisheries Management.

LISA VIDERGAR LUCAS

U.S. Geological Survey
345 Middlefield Road, MS #496
Menlo Park, California 94025

Phone 650-329-4588
Fax 650-329-4327
llucas@usgs.gov

RESEARCH INTERESTS

Develop, adapt, and use numerical models of coupled hydrodynamics, biology, and water chemistry---in conjunction with field investigations---to understand the physical-biological-chemical relationships governing variability in water quality and habitat function in surface water systems such as estuaries, lakes, and rivers.

EDUCATION

Stanford University, Palo Alto, California
Ph.D. in Civil and Environmental Engineering, Environmental Fluid Mechanics Program (1997)

Stanford University, Palo Alto, California
M.S. in Civil Engineering, Environmental Fluid Mechanics Program (1992)

University of Notre Dame, South Bend, Indiana
B.S. in Civil Engineering (1989), Graduated with Honors

RESEARCH AND PROFESSIONAL EXPERIENCE

ECOHYDRODYNAMICIST/RESEARCH ENGINEER, U.S. Geological Survey, Menlo Park, CA (April 2000-Present)

CONSULTING ASSISTANT PROFESSOR, Stanford University, Dept. of Civil and Environmental Engineering, Stanford, CA (October 2002-Present)

NRC POSTDOCTORAL RESEARCH ASSOCIATE, U.S. Geological Survey, Menlo Park, CA (May 1998-April 2000)

VISITING SCIENTIST, Stanford University, Dept. of Civil and Environmental Engineering, Stanford, CA (September 1997-October 2002)

HYDROLOGIST, U.S. Geological Survey, Menlo Park, CA (July 1997-April 1998)

RESEARCH ASSISTANT, Stanford University, Dept. of Civil and Environmental Engineering, Stanford, CA (January 1992-June 1997)

TEACHING ASSISTANT, Stanford University, Dept. of Civil and Environmental Engineering, Stanford, CA (September 1992-June 1996)

STRUCTURAL ENGINEER, Badger Engineers, Inc., Cambridge, MA (August 1989-July 1991)

HIGHLIGHTS

- Recipient of Estuarine Research Federation Cronin Early Career Award (September 2003)
- Elected Secretary of the Estuarine Research Federation (September 2003)
- U.S. Dept. of Interior Star Award (November 2001)
- U.S. Dept. of Interior Star Award (June 2001)
- U.S. Dept. of Interior Star Award (September 2000)
- NRC Postdoctoral Fellowship (1998-2000)
- U.S. Department of Agriculture Postdoctoral Fellowship (1998, declined)
- Josephine de Karman Fellowship (1995)
- Stanford Fellowship for Masters Study (1991-1992)
- McCarthy Scholarship (1988) and Sidney-Kelsey Outstanding Scholar Award (1989), for top Notre Dame Civil Engineering Junior and Senior, respectively
- Graduated from Notre Dame with Honors, Notre Dame Scholar

TECHNICAL PUBLICATIONS

Lucas, L.V., J.E. Cloern, J.K. Thompson, and N. E. Monsen. 2002. Functional variability of habitats in the Sacramento-San Joaquin Delta: restoration implications. Ecological Applications 12(5): 1528-1547.

Lucas, L.V., T. Schraga, C.B. Lopez, J.R. Burau, and A.D. Jassby. 2002. Pulsey, Patchy Water Quality in the Delta: Implications for Meaningful Monitoring. Newsletter, Interagency Ecological Program for the Sacramento-San Joaquin Estuary 15(3): 21-27.

Lucas, L.V. and J.E. Cloern. 2002. Effects of tidal shallowing and deepening on phytoplankton production dynamics: a modeling study. Estuaries 25(4A): 497-507.

Monsen, N. E., J. E. Cloern, L. V. Lucas, and S. G. Monismith. 2002. A comment on the use of flushing time, residence time and age as transport time scales. Limnology and Oceanography 47(5): 1545-1553.

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Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson. 1998. Does the Sverdrup Critical Depth Model Explain Bloom Dynamics in Estuaries? Journal of Marine Research 56: 375-415.

Lucas, L.V. 1997. A Numerical Investigation of Coupled Hydrodynamics and Phytoplankton Dynamics in Shallow Estuaries. Ph.D. Dissertation, Stanford University.

Cloern, J.E., C. Grenz, and L.V. Lucas. 1995. An empirical model of the phytoplankton chlorophyll/carbon ratio -- the conversion factor between productivity and growth rate. Limnology and Oceanography 40(7): 1313-1321.

Vidergar, L.L., J.R. Koseff , and S.G. Monismith. 1993. Numerical models of phytoplankton dynamics for shallow estuaries, in: Hydraulic Engineering '93, ed. H.W. Shen, S.T. Su, and F. Wen. ASCE, 1025-1030.

May, C., J. R. Koseff, L. V. Lucas, J. E. Cloern, and D. H. Schoellhamer. 2003. Effects of spatial and temporal variability of turbidity on phytoplankton blooms. Marine Ecology Progress Series 254: 111-128.

Lopez, C.B., J.E. Cloern, T.S. Schraga, A.J. Little, and L.V. Lucas. Ecological values of shallow-water habitats: Implications for restoration of a highly disturbed ecosystem. (In review, Ecosystems)

Lucas, L.V., D.M. Sereno, J.R. Burau, T.S. Schraga, C.B. Lopez, M.T. Stacey, K.V. Parchevsky, and V.P. Parchevsky. High frequency variability in a small tidal habitat: indications of underlying process. (In prep.)

Lucas, L.V., J.R. Koseff, S.G. Monismith, and J.K. Thompson. Shallow water processes govern systemwide bloom dynamics: A Modeling Study. (In prep.)

Thompson, J.K., J.R. Koseff, S.G. Monismith, and L. V. Lucas. Shallow water processes govern systemwide bloom dynamics: A Field Study. (In prep.)

Brown, L.R., J.K. Thompson, and L.V. Lucas. Distribution, abundance, and possible effects of an invasive clam, *Corbicula fluminea*, in the lower San Joaquin River watershed, California. (In prep.)

Nancy Elizabeth Monsen

U.S. Geological Survey
Water Resources Division
345 Middlefield Road, MS/496
Menlo Park, CA 94025
Ph:(650) 329-4337

1091 Peninsular Court
Los Altos, CA 94024
(650) 968-8585
nemonsen@usgs.gov

Education

1994-2001 Stanford University, Stanford, California
Ph.D., Civil and Environmental Engineering, Environmental Fluid Mechanics
A Study of Sub-tidal Transport in Suisun Bay and the Sacramento-San Joaquin Delta
Advisor: Stephen G. Monismith

1993-1994 University of Colorado/Boulder Boulder, Colorado
M.S., Civil Engineering,Water Resources and Environmental Engineering Emphasis

1989-1993 University of Colorado/Boulder Boulder, Colorado
B.S., Civil Engineering with Distinction

Research Interests/Skills

Study hydrodynamics and associated transport mechanisms in estuary systems using 3D numerical hydrodynamic models. Integrate hydrodynamic knowledge with research in biology/ecology/geochemical disciplines. Primarily interested in Western USA water issues.

Research Experience

Physical Scientist, Post Doctoral Position, U.S.Geological Survey 7/2000-present
Extending transport model developed in Ph.D. research.This interdisciplinary research will focus on how selenium is transported through the Sacramento-San Joaquin Delta and potential pathways of Se to Suisun Bay.

Research Assistant, Stanford University 9/1996-1/2001
Developed a two- (depth averaged) and three-dimensional model of Suisun Bay and the Sacramento-San Joaquin Delta using the TRIM3D hydrodynamic code. Three main questions were addressed during this research. First, how important are mean flows to transport? Second, what type of flow patterns exist at the junctions of larger channels and how do these patterns influence dispersion in the Delta? Finally, how do tidal friction and tidal waves influence the filling and emptying of the Delta during the fortnightly spring-neap tidal cycle? This research was funded by the California Interagency Ecological Program and CALFED.

Research Assistant, CADSWES, University of Colorado/Boulder 6/1993-8/1994
Incorporated temperature and salinity modeling into the reservoir element of PRSYM, a watershed operations model. This application is currently used by the Tennessee Valley Authority (TVA) and Bureau of Reclamation for water management of the TVA and the Colorado River Basin.

Honors and Distinctions

National Science Foundation Fellowship	1993-1996
Top student presentation at the CALFED Science Conference	2000
Colorado Engineering Council Certificate of Merit	1993
American Society of Civil Engineers/Colorado Section Annual Student Award	1993
Milo S. Ketchum Award	1993

Publications

Monsen, N.E., J.E. Cloern, L.V. Lucas, and S.G. Monismith (2002), "A comment on the use of flushing time, residence time, and age as transport time scales," Limnology and Oceanography 47(5): 1545-1553.

Lucas, L.V., J.E. Cloern, J.K. Thompson, and N.E. Monsen (2001), "Functional Variability In Shallow Tidal Habitats: Implications for Restoration of the Sacramento-San Joaquin Delta," *Ecological Applications* 12: 1545-1553.

Monsen, N.E. (2001), *A Study of Sub-Tidal Transport in Suisun Bay and the Sacramento-San Jaoquin Delta, California*, PhD Thesis, Stanford University.

Monsen, N.E., and S.G. Monismith (1999), "Calibration and Verification of Delta TRIM," *IEP Newletter*, **12(4)**:28-34.

Manuscript in review:

Monsen, N.E., J.E. Cloern, J.R. Burau, "Water diversion as an ecosystem disturbance: examples from the Sacramento-San Joaquin River Delta, California," submitted to Water Resources Research.

Presentations at Scientific Meetings

CALFED Science Conference, Sacramento, CA October 6, 2004
Oral presentation: "Water diversion as an ecosystem disturbance: Four examples from the Delta"
California Water and Environmental Modeling Forum, Asilomar, CA February 25, 2004
Oral presentation: "Lessons learned from specific Delta habitats: when, where, and how I use a multi-dimensional model"
Estuarine Research Federation Conference, Seattle, Washington September 16, 2003
Invited oral presentation: "Transport Timescales: What do the really mean?"
CALFED Science Conference, Sacramento, CA January 14, 2003
Oral presentation: "Circulation and Mixing within Delta Flooded Island Habitats: Implications for Ecosystem Restoration"
Ocean Sciences Conference (ASLO/AGU) Honolulu, Hawaii February 13, 2002
Oral presentation: "Transport Timescales: No Two Approaches are Alike"
Estuarine Research Federation Conference, St. Pete Beach, FL November 5, 2001
Oral presentation: "The Importance of Tidal Dispersion with Application to the Sacramento-San Joaquin Delta, CA"
CALFED Science Conference, Sacramento, CA October 3-5, 2000
Oral presentation: "Transport Mechanisms for Water and Scalars in the Delta"
Oral presentation: "Impact of Temporary Barriers and the Yolo Bypass on Transport of Organic Carbon Through the Delta"
Interagency Ecological Program Workshop, Asilomar, CA March 2, 2000
Oral presentation: "Applications of Delta TRIM3D: Residence Times, Water Sources, and Mixing in Shallow Water Habitats"
Bay Delta Modeling Forum Workshop, Sacramento, CA February 4, 2000
Oral presentation: "Analysis of November/December 1999 Salinity Intrusion Event: Real Time Modeling Effort"
AGU Ocean Sciences, San Antonio, TX January 27, 2000
Oral presentation: "Circulation and Salt Transport in the Sacramento-San Joaquin Delta, CA: A Comparison of Two- and Three-Dimensional Modeling approaches using Delta TRIM"
Interagency Ecological Program Workshop, Asilomar, CA February 24, 1999
Poster presentation: "Two Dimensional Modeling of the Sacramento-San Joaquin Delta"
American Geophysical Union Fall Meeting, San Francisco, CA December 8, 1998

Poster presentation: “Two Dimensional Modeling of the Sacramento-San Joaquin Delta”

Other publications/posters where my work has appeared:

Rubissow-Okamoto, Ariel. December 2001. Puzzling Over the Shallows. News from the CALFED Bay-Delta Science Program, Science in Action. Pamphlet.

Lucas, L.V., J. E. Cloern, J.K. Thompson, and N.E. Monsen. 2001. Frank and Millie’s Secrets: Comparison of “Similar” Shallow Tidal Habitats in the Sacramento-San Joaquin River Delta. Poster.

USGS Film Documentary: “Delta Revival: Restoration of a California Ecosystem” 2003

Consultation/Outreach Beyond USGS

1. Guest lecture, Stanford University, GES 50 (The Coastal Environment) November 4, 2004
2. USGS Public Lecture, May 27, 2004, Presentation of “Delta Revival: Restoration of a California Ecosystem”
3. USGS Community Open House, May 31-June 1, 2003
4. Meeting with California Boats and Waterways and US Department of Agriculture to discuss application of Pesticides on Egeria Densa in Franks Tract, June 7, 2002, Davis, CA
    a. Presented model results to discuss circulation patterns and residence time of Franks Tract.
5. CALFED Science Board Worship on Adaptive Management, March 19-20, 2002, Tiburon, CA
    a. Invited as an expert to assist drafting an adaptive management plan for Yolo Bypass floodplain restoration that could be funded by the CALFED Science Board.
6. Interagency Ecological Program Annual Meeting, February 28, 2002, Pacific Grove, CA, February 28, 2002
    a. Showed a video of the Mildred Island September 2001 Field Experiment at the poster session to inform other agencies of this field program.
7. Reviewed journal manuscripts
    a. *Limnology and Oceanography* – 5 manuscripts (2002-2004)
    b. *Estuarine, Coastal and Shelf Science* –1 manuscript (2004)
    c. *San Francisco Estuary and Watershed Science* –1 manuscript (2004)
8. USGS State Regional Directors Meeting, May 23, 2001, Rio Vista, CA
9. Clarified assumptions about flow routing though the Delta (influence of temporary barriers and export pumps) for the CALFED Science Board, March 15, 2001
10. Suisun Bay Place-based meeting 2001, March 22-23, 2001, Ryde, CA
11. Stockton teachers workshop about the Delta, Stockton, CA, March 13, 2001
    a. Gave a general overview of Delta hydrodynamics to Elementary, Jr. High, and High School science teachers who were developing a science curriculum (K-12) based on the Delta.
12. Interagency Ecological Program Estuary Ecology Team Project Work Team meeting, Tiburon, CA, August 24, 2000
    a. Presented an overview of findings from my PhD dissertation
13. Meet occasionally with Rachel Simon, a PhD student in the Environmental Fluid Mechanics Laboratory, Department of Civil/Environmental Engineering, Stanford University to answer questions about the hydrodynamic model TRIM3D.

MICHAEL D. DETTINGER

U.S. Geological Survey
Scripps Institution of Oceanography, Dept 0224
9500 Gilman Drive, UC San Diego, La Jolla, CA 92093-0224
(858) 822-1507; mddettin@usgs.gov
http://tenaya.ucsd.edu/~dettinge

ACADEMIC HISTORY

1977 -- BA Physics, U.C. San Diego (Revelle College)
Summa cum laude, Phi Beta Kappa.

1979 -- MS Civil Engineering, Massachusetts Institute of Technology
"Numerical Modeling of Aquifer Systems under Uncertainty: A Second Moment Analysis"

1991-- MS Atmospheric Sciences, University of California, Los Angeles
"Interannual and Interdecadal Variability of United States Temperatures"

1997-- Ph.D., Atmospheric Sciences, University of California, Los Angeles
"Variations of Continental Climate and Hydrology on Diurnal-to-Interdecadal Scales"

1986—Master's degree committee, Paul MacBeth, University of Nevada, Reno
"LANDSAT Lineaments and Regional Ground-water Pathways in Southern Nevada"

2002-04—Doctoral committee, Jessica Lundquist, Scripps Institution of Oceanography
"Diurnal Cycles of Streamflow in the Western United States"

PROFESSIONAL HISTORY

1979-81: Engineer-scientist, Camp Dresser & McKee, Inc., Walnut Creek, California: *Consulting*
Water-resource evaluations, ground-water flow/transport modeling, and water quality management studies for DOE, Guam EPA, Santa Ana-San Jacinto Basin water-quality districts, and chemical industry.

1981-89: Hydrologist, U.S. Geological Survey, Nevada District, Carson City, Nevada: *Ground-water*
Assessments of geochemistry in bedrock and alluvial aquifers; ground-water flow modeling; regional evaluations and synthesis of hydrogeologic framework and regional flow systems in valley fill , volcanic- and deep carbonate-rock aquifers, eastern Great Basin; and District Ground-water Specialist, including program development and review, and representation of USGS to public forums, Legislative committees, and State Engineer.

1989-90: USGS Graduate Studies Program, UCLA Atmospheric Sciences.
Advisor: Michael Ghil. Emphasis: Climate Dynamics.

1991-94: Hydrologist, U.S. Geological Survey, San Diego, California: *Hydroclimatology*
Study of sensitivity of water resources of California to climate change by analysis of historical hydroclimate and simulations of snowmelt/watershed responses.

1994-97: Research Hydrologist, California District, USGS, San Diego, CA: *Hydroclimatology*
Studies of sensitivity of water resources of California to interannual-decadal climate variations and change by analysis of historical hydroclimate and simulations of snowmelt/watershed responses. Analyses of freshwater-inflow variations to San Francisco Bay and Delta Analysis of large-scale basis and predictability of global, hemispheric, and Western US hydroclimatic variations using historical and paleo-records of atmospheric circulations, trace gases, ocean temperatures, streamflow, ground water, and water quality. Modeling and nonlinear dynamics of

land-air interactions through planetary-boundary layers. Co-developer of UCLA Singular-Spectrum-Analysis Toolkit, 1995.

1996-97: Research Hydrologist, USGS, at NOAA/Climate Diagnostics Center, Boulder, CO

Study of hemispheric-scale ENSO effects on streamflow. Initial medium-range forecasts of Sierra Nevada snowmelt and streamflow. Co-developer of CDC Global Streamflow dataset.

1997-2001: Research Hydrologist, California District, USGS, & Research Associate, Climate Research Division, Scripps Institution of Oceanography, La Jolla, CA: *Hydroclimatology*

Continuations of global, Western, and Sierra Nevada hydroclimatology of precipitation and streamflo,w using historical and paleo-records of atmospheric circulations, trace gases, ocean temperatures, streamflow, ground water, and water quality. Global- to watershed-scale climate downscaling. Medium-range streamflow forecasting, Sierra Nevada, and long-range steamflow forecasting nationwide. Analysis and simulations of ground-water/surface-water sensitivities to climate variations. Simulation of Sierra Nevada watershed sensitivities to projectedclimate changes.

2002-present: Research Hydrologist, Branch of Western Regional Research, USGS, & Research Associate, Climate Research Division, Scripps Institution of Oceanography, La Jolla, CA

Studies of global, Western North American, and Sierra Nevadan hydroclimatology of precipitation, snowpacks, and streamflow using historical and paleo-records of atmospheric circulations, ocean temperatures, streamflow, ground water, and water quality. Occasional long-range national-scale streamflow forecasting. Development of innovative resampling and downscaling approaches for use in evaluating global-change and shorter term climate predictions and their hydrologic consequences. Evaluation of climate-change projections for changes in large-scale Pacific-basin climate modes and resulting streamflow sensitivities. Development and implementation of new and innovative hydrometeorological monitoring methods, Yosemite National Park and Santa Magarita Ecological Reserve. Team leader, CALFED climate-science white paper.

OTHER PROFESSIONAL ACTIVITIES

- **Vice President's National Performance Review Award** for leadership in Mojave Desert Ecosystems planning efforts, 1996. **Water Resources Division representative** on USGS Steering Group for Mojave Desert Ecosystem Initiative Activities, and **Leader** of the Interagency Physical Sciences Subgroup of Mojave Desert Science and Data Management Interagency Working Group, 1995-96 .
- **Program chair and fundraiser**, Pacific Climate (PACLIM) Workshops, 1998 (El Nino 1998), 1999 (Climate and Society), 2000 (Planning for the 2000s), 2001 (Decadcal Climate Variations of the Last 1000 Years), 2002 (Solar Influences on Climate), 2003 (Integrated Mountain Science), and 2004 (Coastal Climates).
- **Panelist**, CALFED Water Management Science Board, October 2004. **Team leader**, CALFED Bay-Delta Program white paper on CALFED's climate-science needs, 2001-present. **Organizer and co-chair**, "Climate Variability and CALFED" sessions, First to Third Biennial CALFED Science Conferences, Sacramento, CA, October 2000, January 2003 and October 2004.
- **Invited speaker**, "Global Implications of Climate Change for Water Supplies", National Academy of Sciences' Sackler Colloquium on the Role of Science in Solving the World's Emerging Water Problems, Irvine, October 2004. **Climate group co-leader**, National Research Council Committee on Hydrologic Science's Workshop on Groundwater Fluxes across Interfaces, Green Bay, May 2002.
- **Moderator**, "Effects of climate change on major California water suppliers" panel, Water Education Foundation's 2003 Climate Change and California Water Resources briefing on California's water future, November 2003.

- **Co-chair** for NASA Working Group on Climate Responses to Direct Solar Forcings, Institute for Study of Planet Earth, Tucson, AZ, March 2000.
- **Invited Climate-Science speaker**, Department of the Interior's Water 2025 Science-Needs Workshop, November 2003.
- **Convener** of sessions on Natural Variations of Groundwater Systems at Fall AGU Meeting, 2000.
- **Hydroclimate representative**, USGS National Ground-water Levels Network Committee, 1995-97. **Keynote speaker**, USGS Western Region Ground-water Availability Workshop, November 2000.
- **Organizing committees**, USGS/Western Governors Association 2004 Southwest Drought Workshop, 2003; Mountain Climate Sciences Symposium, 2003. **Founding member**, CIRMONT Western Mountain Climate Sciences Consortium, 2002-
- **Co-organizer and chair**, "Atmospheric Circulations and the Hydrology of the Pacific Rim" session, American Water Resources Association Annual International Symposium, Honolulu, HI, June 1995.
- **Reviewer** on USGS Research Grade Evaluation peer-review panel, Surface-Water Discipline, Spring 1999. **Review-panel member,** USGS Geologic Division's annual "Multi-disciplinary workshops on the arid southwest" funding program, 2000-2001. **Member** of the national-level Internal Review Team for the USGS Water Resources Division Strategic Plan, Reston, VA, October 1997.
- **Member** of USGS national committee for Report to Congress on a Program for Periodic Assessments of the Nation's Water Availability, Fall 2001 and Summer 2003.
- **Organizer** of 1995, 1996, & 2000 USGS Water Resources Division Hydroclimatology Workshops. **Invited briefing** to USGS Policy Council, "Climate Variability and Runoff Prediction", 1999.
- **Associate Editor,** Water Resources Research, 1998-2000. **Reviewer** for Climatic Change, Journal of Climate, International Journal of Climatology, Geophysical Research Letters, Journal of Hydrometeorology, Journal of Applied Meteorology, Water Resources Research, Journal of Geophysical Research, and various grant programs (e.g., NASA, NOAA, NSF, WRRCs), ongoing.
- **Consulting Editor,** April 1996 issue of Odyssey Magazine (children's science magazine), major theme: "Taking the Earth's Temperature: Too Hot or Not?" **Invited reviewer**, Environmental Defense Fund's "Climate Change and Los Angeles' Water Supply" report, December 2000.

- **Recent invited outreach presentations to:** California Snow Cooperative Survey Workshops, 1997 thru 2001; National Water Resources Forum, 1998; keynote speech for Third National Conference of the National Hydrologic Warning Council, 1999; National Park Service Pacific West Region Annual Meeting, 2000; NASA Earth Sciences Innovations Showcase, 2001; State of San Francisco Estuary Conference, 2001; Desert Tortoise Council, 2002; Sierra Nevada Science Conference, 2002; San Diego City Sustainability Forum, 2002; Northern Arizona University 2003 Southwest Drought Forum, 2003; Natural Resources Law Center, U. Colorado, June 2003; Council for State Governments—West, July 2003; Water Education Foundation's briefing on California's water future, November 2003, US Business Council on Sustainable Development, December 2003; and American Water Works Research Association Foundation briefings, March and November 2004.

- **Recent Collaborators:** David Peterson, Gregory McCabe, Anne Jeton, Randall Hanson, Kate Koczot, David Naftz, Jan vanWagtendonk, and Robert Webb, USGS; Daniel Cayan, Noah Knowles, Jim Simpson, Anthony Westerling, and Warren White, Scripps Institution of Oceanography; Michael Ghil and Ferenc Varadi, UCLA; David Battisti, U. Washington; Henry Diaz, Climate Diagnostics Center; Malcolm Hughes and David Meko, U. Arizona Treering Laboratory; David Stahle, U. Arkansas Treering Laboratory; Kelly Redmond, Western Regional Climate Center; Lynn Ingram and Francis Malamud-Roam, UCB; Norman Miller, LBL; Timothy Brown, Climate Ecosystems and Fire Applications Center; Frank Gehrke, California Cooperative Snow Surveys; Tom Pagano and Phil Pasteris, NRCS; Michael Mann, U. Virgina; Robert Wilby, University of Derby, UK; Myles Allen, Rutherford Appleton Lab, UK; Pascal Yiou, Laboratoire des Sciences du Climat et de l'Environnement, France; Patrick Ng'ang'a, Texas AMU-C; and Jose Marengo, INPE, Brazil.

SELECTED PUBLICATIONS AND REPORTS

Dettinger, M.D., and Wilson, J.L., 1981, First-order analysis of uncertainty in numerical models of groundwater flow, 1, Mathematical development: Water Resources Research, 17, 149-161.

Dettinger, M.D., 1987, Ground-water quality and geochemistry of Las Vegas Valley, Clark County, Nevada, 1981-83: Implementation of a monitoring network: U.S. Geological Survey Water-Resources Investigations Report 87-4007, 69 p.

Dettinger, M.D., 1989, Reconnaissance estimates of natural recharge to desert basins in Nevada, U.S.A., by using chloride-balance calculations: Journal of Hydrology, v. 106, 55-78.

Dettinger, M.D., 1989, Distribution of carbonate-rock aquifers in southern Nevada and the potential for their development--Summary of findings, 1985-88: Special Summary Publication of the Nevada Carbonate Aquifers Program, 20 p.

Dettinger, M.D., and Cayan, D.R., 1995, Large-scale atmospheric forcing of recent trends toward early snowmelt in California: Journal of Climate 8(3), 606-623.

Dettinger, M.D., Ghil, M., and Keppenne, C.L., 1995, Interannual and interdecadal variability of United States surface-air temperatures, 1910-1987: Climatic Change, 31, 35-66.

Dettinger, M.D., Ghil, M., Strong, C.M., Weibel, W., and Yiou, P., 1995, Software expedites singular-spectrum analysis of noisy time series: Eos, Transactions of American Geophysical Union 76(2), pp. 12, 14, 21.

Dettinger, M.D., and Schaefer, D.H., 1996, Hydrogeology of structurally extended terrain in the eastern Great Basin of Nevada, Utah, and adjacent states from geologic and geophysical models: U.S. Geological Survey Hydrologic-Investigations Atlas HA-694-D, 1 sheet.

Jeton, A.E., Dettinger, M.D., and Smith, J.L., 1996, Potential effects of climate change on streamflow, eastern and western slopes of the Sierra Nevada, California and Nevada: U.S. Geological Survey Water Resources Investigations Report 95-4260, 44 p.

Morgan, D.S., and Dettinger, M.D., 1996, Ground-water conditions in Las Vegas Valley, Clark County, NV: 2, Hydrogeology and simulation of ground-water flow: US Geological Survey Water-Supply Paper 2320-B, 124 p.

White, W.B., Lean, J., Cayan, D.R., and Dettinger, M.D., 1997, Response of global upper ocean temperature to changing solar irradiance: Journal of Geophysical Research, 102 (C2), 3255-3266.

Cayan, D.R., Dettinger, M.D., Diaz, H.F., and Graham, N., 1998, Decadal variability of precipitation over western North America: Journal of Climate, 11, 3148-3166.

Dettinger, M.D., Cayan, D.R., Diaz, H.F., and Meko, D., 1998, North-south precipitation patterns in western North America on interannual-to-decadal time scales: Journal of Climate, 11, 3095-3111.

McCabe, G.J., Jr., and Dettinger, M.D., 1999, Decadal variability in the relations between ENSO and precipitation in the western United States: International Journal of Climatology, 19, 1399-1410.

Dettinger, M.D., Cayan, D.R., McCabe, G.M., and Marengo, J.A., 2000, Multiscale streamflow variability associated with El Niño/Southern Oscillation, *in* H.F. Diaz and V. Markgraf, V. (eds.), El Niño and the Southern Oscillation--Multiscale Variability and Global and Regional Impacts: Cambridge University Press, 113-146.

Dettinger, M.D., and Diaz, H.F., 2000, Global characteristics of streamflow seasonality and variability: Journal of Hydrometeorology, 1, 289-310.

Pandey, G.R., Cayan, D.R., Dettinger, M.D., and Georgakakos, K.P., 2000, A hybrid model for interpolating daily precipitation in the Sierra Nevada of California during winter: Journal of Hydrometeorology, 1, 491-506.

Peterson, D.H., Smith, R.E., Dettinger, M.D., Cayan, D.R., and Riddle, L., 2000, An organized signal in snowmelt runoff over the western United States: Journal of Amercican Water Resources Association, 36 (2), 421-432.

Wilby, R.L., and Dettinger, M.D., 2000, Streamflow changes in the Sierra Nevada, California, simulated using statistically downscaled general circulation model output, *in* S. McLaren and D. Kniveton (eds.), "Linking Climate Change to Land Surface Change": Advances in Global Change Research, v. 6, Kluwer Academic Publishers, 99-121.

Cayan, D.R., Kammerdiener, S., Dettinger, M.D., Caprio, J.M., and Peterson, D.H., 2001, Changes in the onset of spring in the western United States: Bulletin, American Meteorological Society, 82, 399-415.

Dettinger, M.D., Battisti, D.S., Garreaud, R.D., McCabe, G.J., and Bitz, C.M., 2001, Interhemispheric effects of interannual and decadal ENSO-like climate variations on the Americas, in V. Markgraf (ed.), Interhemispheric climate linkages: Present and Past Climates in the Americas and their Societal Effects: Academic Press, 1-16.

Stahle, D.W., Therrell, M.D., Cleaveland, M.K., Cayan, D.R., Dettinger, M.D., and Knowles, N., 2001, Ancient blue oaks reveal human impact on San Francisco Bay salinity: Eos, 82, 141, 144-145.

Ghil, M., Allen, M.R., Dettinger, M.D., Ide, K., Kondrashov, D., Mann, M.E., Robertson, A.W., Saunders, A., Y.Tian, Varadi, F., and Yiou, P., 2002, Advanced spectral methods for climatic time series: Reviews of Geophysics, 40(3), 1003, doi:10.1029/2000RG000092, 1-41.

McCabe, G.J., and Dettinger, M.D., 2002, Primary modes and predictability of year-to-year snowpack variations in the western United States from teleconnections with Pacific Ocean climate: Journal of Hydrometeorology, 3, 13-25.

Cayan, D.R., Dettinger, M.D., Redmond, K.T., McCabe, G.J., Knowles, N., and Peterson, D.H., 2003, The transboundary setting of California's water and hydropower systems--Linkages between the Sierra Nevada, Columbia River, and Colorado River hydroclimates: Chapter for Diaz, H.F., and Woodhouse, B. (eds.), Climate and Transboundary Issues: 237-262.

Dettinger, M.D., and Cayan, D.R., 2003, Interseasonal covariability of Sierra Nevada streamflow and San Francisco Bay salinity: Journal of Hydrology, 277 (3/4), 164-181 [doi:10.1016/S0022-1694(03)00078-7].

Dettinger, M.D., Cayan, D.R., Meyer, M.K., and Jeton, A.E., 2004, Simulated hydrologic responses to climate variations and change in the Merced, Carson, and American River basins, Sierra Nevada, California, 1900-2099: Climatic Change, 62, 283-317.

Lundquist, J.D., Cayan, D.R., and Dettinger, M.D., 2004, Spring onset in the Sierra Nevada—When is snowmelt independent of elevation?: Journal of Hydrometeorology, 5, 325-340.

Pagano, T., Pasteris, P., Dettinger, M., Cayan, D., and Redmond, K., 2004, Water year 2004—Western water managers feel the heat: Eos, Transactions of the American Geophysical Union, 85, 385-387.

Simpson, J.J., Dettinger, M.D., Gerhke, F., McIntyre, T.J., and Hufford, G.I., 2004, Hydrologic scales, cloud variability, remote sensing and models—Implications for forecasting snowmelt and streamflow: Weather and Forecasting, 19, 251-276.

Stewart, I., Cayan, D.R., and Dettinger, M.D., 2004 Changes in snowmelt runoff timing in western North America under a 'Business as Usual' climate change scenario: Climatic Change, 62, 217-232.

Dettinger, M.D., Redmond, K.T., and Cayan, D.R., in press, Winter orographic-precipitation ratios in the Sierra Nevada—Large-scale atmospheric circulations and hydrologic consequences: Journal of Hydrometeorology.

Hidalgo, H.G., Cayan, D.R., and Dettinger, M.D., in press, Sources of variability of evapotranspiration in California: Journal of Hydrometeorology.

Stewart, I., Cayan, D., and Dettinger, M., in press, Changes towards earlier streamflow timing across western North America: Journal of Climate.

Dettinger, M.D., in journal review, From climate-change spaghetti to climate-change distributions for 21st Century California: submitted to San Francisco Estuary and Watershed Science, 30 p.

Daniel R. Cayan
Scripps Institution of Oceanography & U.S. Geological Survey
9500 Gilman Drive - 0224
La Jolla, California 92093-0224
(858) 534-4507
dcayan@ucsd.edu

Education

1971 B.S. Degree (Meteorology and Oceanography)(University of Michigan)
1972 M.S. Degree (Physical Oceanography) (University of Michigan)
1977 M.S. Degree (Meteorology) (UC Davis, UC San Diego)
1990 Ph.D. Degree (Oceanography) (UC San Diego) (Russ Davis, Adviser)

Employment

1991-present	Oceanographer (half-time) U.S. Geological Survey, Water Resources Division
1993-present	Researcher (half-time) Climate Research Division, Scripps Institution of Oceanography
1996-present	Director, Climate Research Division, Scripps Institution of Oceanography

Professional Memberships

American Meteorological Society
American Geophysical Union

Selected Publications:

Stewart, I.T., D.R. Cayan, and M.D. Dettinger, 2004: Changes towards earlier streamflow timing across western North America. *J. Climate (in press).*

Bromirski, P.D., D.R. Cayan, and R.E. Flick, 2004: Wave spectral energy variability in the Northeast Pacific. *J. Geophysical Research-Oceans (in press).*

Lundquist, J., D. Cayan, and M. Dettinger, 2004. Spring onset in the Sierra Nevada: When is snowmelt independent of elevation? *J. Hydromet*., **5**, 325-340.

Hayhoe, K., D.R. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville, 2004: Emissions pathways, climate change, and impacts on California. *PNAS* **101**(34)**,** 12422-12427.

Westerling, A.L., D.R. Cayan, T.J. Brown, B. Hall, and L.G. Riddle, 2004: Climate, Santa Ana Winds and Autumn Wildfires in Southern California. EOS **85**(31), 289-300.

Knowles, N., D.R. Cayan, 2004: Elevational dependence of projected hydrologic changes in the San Francisco estuary and watershed. *Climatic Change* **62**:319-336.

Gershunov, A. and D.R. Cayan, 2003: Heavy daily precipitation frequency over the contiguous U.S.: Sources of climatic variability and seasonal predictability. *J. Climate*. **16**(16)**,** 2752–2765.

Cayan, D.R., M.D. Dettinger, K. Redmond, G. McGabe, N. Knowles, D.H. Peterson, 2003. The transboundary setting of California's water and hydropower systems—linkages between the Sierra Nevada, Columbia, and Colorado hydroclimates. Advances in Global Change Research **16,** Climate and Water, Transboundary Challenges in the Americas. Diaz, H.F., and Woodhouse, B. (*eds.*).

Lundquist, J.D., D.R. Cayan, 2002: Seasonal and spatial patterns in diurnal cycles in streamflow in the western United States. *J. Hydrometeorology*, **3**(5), 591-603.

Knowles, N., D.R. Cayan, 2002: Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco estuary. *Geophysical Research Letters,* **29**(18), 1891.

Cayan, D.R., S. Kammerdiener, M. D.Dettinger, J. M. Caprio, and D. H. Peterson, 2001: Changes in the onset of spring in the western United States. *Bull. Am. Met Soc*., **82**(3), 399-415.

Biondi, F., A. Gershunov, and D. Cayan, 2001: North Pacific decadal climate variability since 1661. *J. Climate, Letters,* **14**(1), 5-10.
Pandey, G.R., D.R. Cayan, and K.P. Georgakakos, 1999: Precipatation structure in the Sierra Nevada of California during winter. *J. Geophysical Research*, 104(**D10**), 12,019-12,030.
Cayan, D.R., K.T. Redmond, and L.G. Riddle, 1999: ENSO and hydrologic extremes in the Western United States. *J. Climate*, **12**(9), 2881-2893.
Cayan, D.R., M.D. Dettinger, H.F. Diaz, and N.E. Graham, 1998: Decadal climate variability of precipitation over western North America. *J. Climate*, **11**(2), 3148-3166.
McGowan, J.A., D.R. Cayan, and L.M. Dorman, 1998: Climate-ocean variability and ecosystem response in the northeast Pacific. *Science*, **281**, 210-217.
Cayan, D. R., 1996: Interannual Climate variability and snow pack in the western United States. *J. Climate*, **9**(5), 928-948.
Dettinger, M. D. and D. R. Cayan, 1995: Large-scale atmospheric forcing of recent trends toward early snowmelt runoff in California. *J. Climate*, **8**, 606-623.

PhD's Supervised:
Noah Knowles (degree granted 2000)
Jessica Lundquist (degree granted 2004)
Steven Taylor (current)

Recent Collaborators
M. Dettinger, USGS San Diego; D. Peterson, USGS Menlo Park; G. McCabe, USGS, Denver, CO; H. Diaz, NOAA CDC, Boulder, CO; D. Meko, U Arizona, Tucson; M. Hughes, U Arizona, Tucson; W. White, SIO; A. Miller, SIO; K. Redmond, WRCC, Reno, NV; J. Lean, Naval Res Lab, Washington, DC; A. Weinheimer, SIO; J. McGowan, SIO; F. Biondi, Univ. Nev, Reno; A. Gershunov, SIO; A. Westerling, SIO; N. Knowles, SIO; R. Nemani, U Montana; W. Reisen, UC Davis; J. Burns, UCSD

Neil Kamal Ganju

Hydraulic Engineer

U.S. Geological Survey

Placer Hall

6000 J Street

Sacramento, CA 95819-6129

Education

2001-present: Ph.D. student, Civil and Environmental Engineering, University of California, Davis

Adviser: David H. Schoellhamer

Research: Estuarine geomorphic prediction

1999-2001: M.S., Coastal and Oceanographic Engineering, University of Florida, Gainesville

Adviser: Ashish J. Mehta

Thesis: Trapping organic-rich fine sediment in an estuary

1994-1998: B.S., Civil and Environmental Engineering, University of Michigan, Ann Arbor

Current Research at the USGS – July 2001 to present

Seasonal study of tidal wetland fluxes, measuring dissolved organic carbon and suspended-sediment fluxes to and from Browns Island, California. Funded by CALFED, in collaboration with USGS Carbon Project.

Measurement of sediment fluxes through large estuarine cross-sections, for establishing long-term trends of sediment transport through Suisun Bay, California. Funded by Regional Water Board, in collaboration with USGS Hydrodynamics Project.

Investigation of microscale fine sediment properties, such as the response of flocculation to sediment concentration, salinity, and hydrodynamic conditions. Funded by USGS Priority Ecosystem Science program.

Development of 1, 2, and 3-D models for simulating long-term estuarine geomorphology. Funded by multiple programs, in collaboration with UC Davis.

Selected publications

1. Buchanan, P.A., and Ganju, N.K., 2002, Summary of suspended-sediment concentration data, San Francisco Bay, California, water year 2000: U.S. Geological Survey Open File Report 02-146. URL http://water.usgs.gov/pubs/of/ofr02146/
2. Gartner, J. W. and Ganju, N. K., 2002, A preliminary evaluation of near-transducer velocities collected with low-blank acoustic Doppler current profiler: Proceedings, ASCE 2002 Hydraulic Measurements and Experimental Methods Conference, Estes Park, Colorado, July 28 – August 1, 2002.
3. McKee, L., Ganju, N., Schoellhamer, D., Davis, J., Yee, D., Leatherbarrow, J., and Hoenicke, R., 2002, Estimates of suspended sediment flux entering San Francisco Bay from the Sacramento and San Joaquin Delta: Report prepared for the Sources Pathways and Loading Workgroup of Regional Monitoring Program for Trace Substances in the San Francisco Estuary, San Francisco Estuary Institute, Oakland, California, 28 p. http://www.sfei.org/watersheds/reports/Delta_sediment_loads/MallardIssedimentloads.pdf
4. Schoellhamer, D.H., Shellenbarger, G.G., Ganju, N.K., Davis, J.A., and McKee, L.J., 2003, Sediment dynamics drive contaminant dynamics: The Pulse of the Estuary: Monitoring and Managing Contamination in the San Francisco Estuary, San Francisco Estuary Institute, Oakland, California, p. 21-26. http://www.sfei.org/rmp/pulse/pulse2003.pdf
5. Ganju, N.K., Schoellhamer, D.H., Murrell, M.C., Gartner, J.W., and Wright, S.A., in press, Constancy of the relation between floc size and density in San Francisco Bay: journal article, Proceedings of the 7th International Conference on Estuarine and Nearshore Cohesive Sediment Transport Processes, Glouchester Point, Virginia, October 1-4, 2003.
6. Downing, B., Wheeler, G., Emerson, S., Ganju, N., and Bergamaschi, B., 2003, Continuous, real-time optical measurement of DOC fluxes in a tidal wetland: Proceedings of the 6th biennial State-of-the-Estuary Conference, Oakland, California, October 21-23, 2003, p. 73.
7. Swanson, K., Shellenbarger, G.G., Schoellhamer, D.H., Ganju, N. K., Athearn, N., and Buchanan, P., 2003, Desalinization, erosion, and tidal changes following the breaching of Napa salt pond 3: Proceedings of the 6th biennial State-of-the-Estuary Conference, Oakland, California, October 21-23, 2003, p. 156.
8. Takekawa, J., Demers, S., Woo, I., Athearn, N., Ganju, N., Shellenbarger, G., Schoellhamer, D., and Perry, W.M., 2003, A bathymetry system for measuring sediment accumulation in tidal marsh restoration projects: Proceedings of the 6th biennial State-of-the-Estuary Conference, Oakland, California, October 21-23, 2003, p. 157.
9. Buchanan, P.A., and Ganju, N.K., 2003, Summary of suspended-sediment concentration data, San Francisco Bay, California, water year 2001: U.S. Geological Survey Open-File Report 03-312. URL http://water.usgs.gov/pubs/of/2003/ofr03312/index/index.htm

10. Ganju, N.K., Schoellhamer, D.H., Warner, J.C., Barad, M.F., and Schladow, S.G., 2004, Tidal oscillation of sediment between a river and a bay: a conceptual model: Estuarine, Coastal and Shelf Science, v. 60, no. 1, p. 81-90.

11. Buchanan, P.A., and Ganju, N.K., 2004. Summary of suspended-sediment concentration data, San Francisco Bay, California, Water Year 2002: U.S. Geological Survey Open File Report 2004-1219. http://pubs.water.usgs.gov/ofr2004-1219/

12. Ganju, N.K., Bergamaschi, B., and Schoellhamer, D.H., Measurement of water, sediment, and carbon fluxes from a tidal wetland: submitted to Estuaries.

13. McKee, L., Ganju, N.K., and Schoellhamer, D.H., Estimates of suspended sediment entering San Francisco Bay from the Sacramento and San Joaquin Delta, San Francisco Bay, California: submitted to Journal of Hydrology.

14. Buchanan, P.A., and Ganju, N.K., in preparation, Summary of suspended-sediment concentration data in San Francisco Bay, California, water year 2003: USGS Open File Report.

Estuarine system and pathway of atmospheric influence on estuary.

C.V.

David H. Peterson, Research Oceanographer, USGS, WRD, WR

EDUCATION: Ph.D., University of Washington, Seattle, Washington, 1967, Oceanography (minor in geochemistry); M.S., University of Minnesota, Minneapolis, Minnesota, 1962, geology (minors in physical chemistry and petroleum engineering); B.A., Augustana College, Rock Island, Illinois, 1959, Geology.

Position: Project Chief "Geochemistry and Hydroclimatology of Riverine and Estuarine Waters" 1967-present

Present Research

Alpine hydroclimatology: Defining the linkages between large scale atmospheric circulation, snowmelt river discharge, and river chemistry and geology. Our research is largely observationally based, and part of a multi-institutional/multi-agency effort including developing/maintaining a hydroclimate monitoring network in central Sierra Nevada.

Motivation: Water is the most important natural resource in western U.S., climate is the most important source of variability in water resources and snow water is an important scientific and management issue.

Study area: Western U.S., with a focus on California.

Scientific Leadership

Grandpa of the USGS San Francisco Bay estuarine program, 1967, father (with the assistance of Chris Mooers) of the Pacific Climate Workshop (PACLIM), 1983, and brother of the

Sierra Nevada hydroclimate monitoring and research effort, 1999, with a Yosemite National Park focus.

Collaborations

Calibration and prediction of Tuolumne River inflow to the head of the Hetch Hetchy reservoir (SFPUC, SF Water and Power, USGS, Denver); Calibration of Tenya River flow, Tenya Bridge (USGS, Denver, YNP); lightning as a nitrate source in YNP (SIO, UC, Merced, YNP, SF Water and Power); hydroclimate characteristics of volcanic vs. granitic watersheds (UC, Berkeley), hydroclimatology of central Sierra Nevada including river chemistry (too numerous to list); snowmelt river discharge characteristics western U.S. (USGS, Mapping Division, Menlo Park, CA and NOAA, Sacramento, CA.).

Scientific Presentations/Workshops

Too numerous to list (over 50). Examples include: invitations to international and national workshops (Goldberg, et.al., 1971; Biggs, et.al., 1983; Peterson, et.al., 1987; Peterson et. al., 1988; Peterson, 1989 and White House sponsored meeting 1995; Presentations to NAS review panel of USGS, WRD, 1987; Western USGS District Chiefs, 1987; numerous Universities, Government Agencies (most recent 3rd annual Yosemite National Park Hydroclimate meeting Oct. 2004, which I started and YNP now sponsors this meeting).

Outreach

Too numerous to list (over 50). Examples include: talks to k-6, audiences from San Joaquin farmers to the Commonwealth Club, part of a national 1-hour TV program on SF Bay (NOVA series), Women League of Voters docent on SF Bay cruise, article in American Scientist, provide materials to Yosemite Institute, and most recently, an article published in Nature Notes.

AWARDS

American Chemical Society Research Assistant, 1959
Pre Doctoral Research Associate, 1962
Special Service Award, March 1971
Group Special Achievement Award, December 1978
Meritorious Program Award, March 1980
U.S.G.S., Geologic Division Branch Best Paper 1986
Dept. of Interior Superior Service Award, 1988
Superior Performance Award, 1991
Meritorious Service, 2000

BIBLIOGRAPHY (Last 5 years plus a few earlier examples cited herein)

Goldberg, E.D., R. Carpenter, J. Chow, J. Duce, J. Noakes, A. Preston, J. Ui, D. Peterson, K. Szekielda, T. Metcalf, 1971, Fluxes of materials to the marine environment. In: Marine Environmental Quality: Suggested Research Programs for Understanding Man's effect on the Oceans, National Academy of Sciences, Washington, p. 5-28.

Biggs, R., J. Coleman, E. Cronian, T. Fischer, C. Officer, J. Pierce and D. Peterson, 1983, Suspended and Dissolved Matter in Estuaries. In: Fundamental Research in Estuaries: The Importance of an Interdisciplinary Approach. Studies in Geophysics NRC Report, National Academy of Science Press, Washington, p. 63-79.

Peterson, D.H., D.R.Cayan, J. DiLeo-Stevens, and T.G. Ross, 1987: Some effects of climate variability on hydrology in western North America. Proceedings of the Vancouver Symposium, August 1987. IAHS Publ. No. 168, 45-62.

Peterson, D.H., Hager, S.W., Schemel, L.E. and Cayan, D.R., 1988 Riverine C,N, Si, and P transport to the Coastal Ocean: An overview. In: Lecture Notes on Coastal and Estuarine studies, Vol. 22. B.O. Jansson (Ed.) Coastal-Offshore Ecosystem Interactions. Springer-Verlag Berlin, p. 227-253.

Peterson, D.H.,1989, (Ed.) Geophysical Monograph 55, Aspect of Climate Variability in the Pacific and the Western Americas, American Geophysical Union. Wash., D.C., 445pp.

Peterson, Cayan, DiLeo, Noble and Dettinger, 1995, The Role of Climate in Estuarine Variability, American Scientist 83: 58-67.

Peterson, D.H., Smith, R.E., Dettinger, M.D., Cayan, D.R., and Riddle, L.G., 1999, An organized signal in snowmelt runoff over the west: Proceedings, Specialty Conference on Potential Consequences of Climate Variability and Changes to Water Resources of the United States, American Water Resources Association (B.D. Adams, ed.), 129-137.

Cayan, D.R., Peterson, D.H., Riddle, L.G., Dettinger, M.D., and Smith, R.E., 1999, The spring runoff pulse from the Sierra Nevada: Preprints, American Meteorological Society's 14th Conference on Hydrology, Dallas, January 1999, 77-79.

Peterson, D.H., Smith, R.E., Dettinger, M.D., and Cayan, D.R., 2000, Forecasting spring discharge in the West: A step toward forecasting stream chemistry, in D.W. Morganwalp and H.T. Buxton, eds. Proceedings of the Technical Meeting, Contamination of Hydrologic Systems and Related Ecosystems, Charleston, SC, March 1999: U.S. Geological Survey Water Resources Investigations Report 99-4018B, 8p.

Cayan, D.R., Peterson, D.H., Riddle, L., Dettinger, M.D., and Smith, 2000, The spring runoff pulse from the Sierra Nevada. Preprints, American meteorological Society's 14th Conference of Hydrology, Dallas January 1999, 77-79.

Peterson, D.H., Cayan, D.R., Smith, R.E., Dettinger, M.D. and Riddle, L.G., 2000, Retrospective Appraisal of the 200 Maximum Flow Forecasts (http://meteora.ucsd.edu/cap/max_discharge_fest.html)

Stacey, P.E., Greening, H., Peterson, D. and Tomasko, D., 2000, Summary and Conclusions, Chapter 8, AGU monograph, Contributions of Atmospheric Nitrogen Deposition to U.S. Estuaries.

Peterson, D.H., Dettinger, M.D., Cayan, D.R., Smith, R.E., and Riddle, L." 2000, An organized signal in snowmelt runoff over the Western United States: Journal of the American Water Resources Association, v. 36, no. 2, pp. 421-432.

Cayan, D.R., Kammerdiener, S., Dettinger, M.D., Caprio, J.M., and Peterson, D.H., 2001, Changes in the onset of spring in the western United States: Bulletin, American Meteorological Society, v.82, no. 3, p. 399-415.

Peterson, D.H., Cayan, D.R., Smith, R.E., Dettinger, M.D. and Riddle, L., 2002, An Experimental Forecast of Maximum Daily Snowmelt Discharge for the year 2002. (http://meteora.ucsd.edu/cap/max discharge 2002. html).

DiLeo, J., Butler, M., Cayan, D., Clow, D., Dettinger, M., Gehvke, F., Hager, S., Lundquist, J., McCurdy, G., Peterson, D., Redmond, K., Riddle, L., Smith, R. and Van Wagtendonk, J., 2003, A Notebook of Hydroclimatology Sites/Activities, Yosemite National Park, USGS Open File Report, 39 p. http://sfbay.wr.usgs.gov/access 1 hydroclim/site book.pdf

Peterson, D., Smith, R., Hager, S., Huber, K., Dettinger, M. and DiLeo, J., 2003, Alpine Hydroclimatology, exploring the mystery of salinity change in portions of the Stanislaus and Merced Rivers, http://sfbay.wr.usgs.gov/access/HydroClim/HydroClimTutorial.pdf

Peterson, D., Smith, R. and Hager, S. 2004, A walk through the hydroclimate network in Yosemite National Park: River Chemistry, 16p. http://sfbay.wr.usgs.gov/access/HydroClim/NatNote_Dhpet.pdf

Peterson, D., Smith, R., Hager, S., Cayan, D. and Dettinger, M., 2004, Air Temperature and

Snowmelt Discharge Characteristics, Merced River at Happy Isles, Yosemite National Park, Central Sierra Nevada, Proceedings of the Twentieth Annual Pacific Climate Workshop, p.53-64.

Cayan, D.R. Dettinger, M.D., Redmong, K.T., McCabe, G.J., Knowles, N., and Peterson, D.H., 2005, The tansboundary Setting of California's Water and Hydropower Systems-Linkages between the Sierra Nevada, Columbia River, and Colorado River Hydroclimates: Chapter for Diaz, H.F., and Woodhouse, B (eds.), Climate and Transboundary Issues: 25 p.

Directors Approval for Publication:

Peterson, D., Smith, R., Hager, S., Hickie, J., Dettinger, M., and Huber, K., A top-Down Hydroclimate Monitoring Network in Yosemite National: Response of Alpine Riverine Chemistry to Atmospheric Drivers (to be submitted to EOS).

In Review

Peterson, D., Smith, R., Stewart, I., Knowles, N., Soulard, C., and Hager, S., Snowmelt Discharge Characteristics, Sierra Nevada, California to be submitted to San Francisco Estuary and Watershed Science.

CURRICULUM VITA

Janet Kay Thompson
U.S. Geological Survey
Water Resources Division
345 Middlefield Road MS 496
Menlo Park, California 94025
(650)329-4364
jthompso@usgs.gov

Education

- Stanford University, Stanford, California, Ph.D. Civil and Environmental Engineering
- California State University, San Francisco, California, M.A. Marine Biology
- Lewis and Clark College, Portland, Oregon, B.S. Biology

Experience

- 1982-present: Research Scientist, U.S. Geological Survey Menlo Park, California:
- 1972: Teaching Assistant, Oregon Institute of Marine Biology, University of Oregon; Lewis and Clark College
- 1971: Teaching Assistant, Lewis and Clark College

Research Interest:

Ecology and physical dynamics of aquatic systems based on long term (30 year) investigations of the San Francisco Bay and freshwater Delta that has included studies of the following: the coupling between, and interdependence of benthic and pelagic communities; biogeochemical processes related to benthic organism accumulation of natural and anthropogenic elements; the physical dynamics of organic and inorganic particle transfer to the bed; the study of benthic community dynamics in response to natural and anthropogenic stress; and the response of aquatic ecosystems to non-indigenous species.

Highlights:

U.S. Department of the Interior, Superior Service Award, 2003
Science Advisory Committees: California Bay/Delta Food Chain Committee-1999-present: California Sea Grant Committee on Exotic Species 1996-present; Interagency Ecological Program Review of Long-term Fish Monitoring Program; CALFED Exotic Species Program 2000-present
Editorial Board: Aquatic Nuisance Species Digest (1999-present)

Postdoctorates: Dr. Laurent Chauvaud, Dr. Rene Takesue

Relevant Publications:

Carlton, J.T., Thompson, J.K., Schemel, L.E., Nichols, F.H., 1990. Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam *Potamocorbula*

amurensis. I. Introduction and dispersal, *Marine Ecology Progress Series*, 66, pp. 81-94.

Nichols, F.H., Thompson, J.K., Schemel, L.E., 1990. Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam *Potamocorbula amurensis*. II. Displacement of a former community, *Marine Ecology Progress Series*, 66, pp. 95-101

Monismith, Stephen G., Koseff, J. R., Thompson Janet K., O'Riordan, Catherine A., and Nepf, Heidi M. 1990. A study of Model Bivalve Siphon Currents: *Limnology & Oceanography* v. 35, no. 3, p. 680-696

Cole, B.E., J.K. Thompson, and J.E. Cloern. 1992. Measurement of filtration rates by infaunal bivalves in a recirculating flume. Marine Biology, 113: 219-225.

Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson. 1998. Does the Sverdrup critical depth model explain bloom dynamics in estuaries? *Journal of Marine Research*, 56:375-415

Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson. 1999. Processes governing phytoplankton blooms in estuaries. Part I: The local production-loss balance. *Marine Ecology Progress Series* v. 187, pp. 1-15

Lucas, L.V., J.E. Cloern, J.R. Koseff, S.G. Monismith, and J.K. Thompson. 1999. Processes governing phytoplankton blooms in estuaries. Part II: The role of horizontal transport. *Marine Ecology Progress Series* v. 187, pp. 17-30

Thompson, J. K., 1999. The effect of infaunal bivalve grazing on phytoplankton bloom development in South San Francisco Bay, PhD Thesis, Stanford University, Dept. of Civil and Environmental Engineering, Stanford, CA: 419p.

Lucas, L.V., J. E. Cloern, J.K. Thompson, and N.E. Monsen. 2002. Functional variability of shallow tidal habitats in the Sacramento-San Joaquin Delta: restoration implications. *Ecological Applications* 12(5): 1528-1547.

Crimaldi, J.P. J.K. Thompson, J.H. Rosman, R. J. Lowe, J. R. Koseff. 2002. Hydrodynamics of larval settlement: The influence of turbulent stress events at potential recruitment sites. *Limnology and Oceanography*. 47(4):1137-1151

Parchaso, F. and J.K. Thompson, 2002, The influence of hydrologic processes on reproduction of the introduced bivalve *Potamocorbula amurensis* in Northern San Francisco Bay, California, *Pacific Science*, 56(3):329-345

Brown, C.L., F. Parchaso, J.K. Thompson, S.N. Luoma. 2003. Assessing toxicant effects in a complex estuary: A case study of effects of silver on reproduction in the bivalve, *Potamocorbula amurensis,* in San Francisco Bay. *Human and Ecological Risk Assessment*. 9(1):95-119

Chauvaud, L., J. K. Thompson, J. E. Cloern, and G. Thouzeau. 2003. Clams as CO_2 generators: The *Potamocorbula amurensis* example in San Francisco Bay. *Limnology and Oceanography* 48(6):2086-2092

Thompson, JK. 2004. One estuary, one invasion, two responses: phytoplankton and benthic community dynamics determine the effect of an estuarine invasive suspension feeder. *In press*, The comparative Roles of Suspension Feeders in Ecosystems, S. Olenin and R. Dame Editors.

December 2004

David Schoellhamer

Research Hydrologist, U.S. Geological Survey, Sacramento
Associate Adjunct Professor of Civil and Environmental Engineering, UC Davis
Email: dschoell@usgs.gov

Research and work experience relevant to geomorphic modeling, the Delta, and Suisun Bay

1993-present: Research Hydrologist, U.S. Geological Survey, Sacramento, California. Chief of the San Francisco Bay suspended-sediment transport processes project. I am responsible for the study design, technical direction, technical quality, research products, funding, reporting, colleague and agency relations, supervision, and administration of the project. I am the co-PI for the CALFED supported project *Sedimentation in the Delta and Suisun Bay*. More information is available at http://ca.water.usgs.gov/sfbay/sedtrans/ .

2003-present: Associate Adjunct Professor, Civil and Environmental Engineering Department, UC Davis: I conduct research in collaboration with faculty and graduate students, serve on thesis and dissertation committees, teach classes on sediment transport and San Francisco Bay, give seminars, and I have helped organize guest speakers for seminars. I am co-PI (with Dr. Bassam Younis) on a project developing an estuarine landscape model for Suisun Bay that is funded by the UC Water Resources Center. More information is available at http://cee.engr.ucdavis.edu/faculty/schoellhamer/ .

Scientific Leadership relevant to geomorphic modeling, the Delta, and Suisun Bay

U.S. Geological Survey Federal Engineer of the Year, December 2004.

Program co-chair for the 2004 California Bay-Delta Authority Science Conference, October 2004.

Organizing Committee for the Seventh International Conference on Nearshore and Estuarine Cohesive Sediment Transport Processes held in Virginia in October 2003. Co-editor of the peer-reviewed proceedings.

U.S. Army Corps of Engineers, Fine Sediment Engineering Research Needs Advisory Panel, Vicksburg, Mississippi, July 24-25, 2001. The panel included leading scientists from academia, government, and the private sector and made recommendations to the Corps on what research topics they should pursue during the next decade to help advance science and to better accomplish the Corps' mission.

San Francisco Airport Runway Expansion Science Panel, 1999-2003. The panel was chaired by Dr. Jerry Schubel and includes scientists from around the country. Sediment management was a key issue regarding the planned multibillion dollar airport expansion.

Hydro-geomorphic Advisory Team of the Bay Area Regional Wetlands Ecosystem Goals Project, 1996-1999

Peer reviewed publications relevant to geomorphic modeling, the Delta, and Suisun Bay

Brennan, M.L., Schoellhamer, D.H., Burau, J.R., and Monismith, S.G., 2002, Tidal asymmetry and variability of bed shear stress and sediment bed flux at a site in San Francisco Bay, USA, in Winterwerp, J.C. and Kranenburg, C., ed., Fine Sediment Dynamics in the Marine Environment: Elsevier Science B.V., p. 93-108.

Ganju, N.K., Schoellhamer, D.H., Murrell, M.C., Gartner, J.W., and Wright, S.A., in press, Constancy of the relation between floc size and density in San Francisco Bay: Proceedings of the 7th International Conference on Estuarine and Nearshore Cohesive Sediment Transport Processes, Glouchester Point, Virginia, October 1-4, 2003.

Ruhl, C.A., and Schoellhamer, D.H., 2004, Spatial and Temporal Variability of Suspended-Sediment Concentrations in a Shallow Estuarine Environment: San Francisco Estuary and Watershed Science. v. 2, no. 2, article 1. http://repositories.cdlib.org/jmie/sfews/vol2/iss2/art1

Schoellhamer, D.H., 2001, Influence of salinity, bottom topography, and tides on locations of estuarine turbidity maxima in northern San Francisco Bay, in McAnally, W.H. and Mehta, A.J., ed., Coastal and Estuarine Fine Sediment Transport Processes: Elsevier Science B.V., p. 343-357. URL: http://ca.water.usgs.gov/abstract/sfbay/elsevier0102.pdf

Schoellhamer, D.H., and Wright, S.A., 2003, Continuous monitoring of suspended sediment discharge in rivers by use of optical backscatterance sensors, in Bogen, J., Fergus, T., and Walling, D.E., ed., Erosion and Sediment Transport Measurement: Technological and Methodological Advances: International Association for Hydrological Science Publication 283, p. 28-36. http://www.cig.ensmp.fr/~iahs/redbooks/a283/28304.htm

Warner, J.C., Schoellhamer, D.H., Ruhl, C.A., and Burau, J.R., 2004, Floodtide pulses after low tides in shallow subembayments adjacent to deep channels: Estuarine, Coastal and Shelf Science, v. 60, no. 2, p. 213-228.

Wright, S.A., and Schoellhamer, D.H., 2004, Trends in the Sediment Yield of the Sacramento River, California, 1957 – 2001: San Francisco Estuary and Watershed Science. v. 2, no. 2, article 2. http://repositories.cdlib.org/jmie/sfews/vol2/iss2/art2

Wright, S.A., and Schoellhamer, D.H., submitted, Suspended sediment transport where rivers become estuaries: Sacramento – San Joaquin River Delta, water years 1999-2002: Water Resources Research.

Education

University of Florida, Ph.D., Coastal and Oceanographic Engineering, 1993

University of California at Davis, M.S. Civil Engineering, 1983

University of California at Davis, B.S. Civil Engineering, 1982

A complete curriculum vitae is available at http://cee.engr.ucdavis.edu/faculty/schoellhamer/ .

U.S. Geological Survey, WRD
MS 496, Bldg. 15, Rm. 3024
345 Middlefield Rd.
Menlo Park, CA 94025

Phone: 650 329 4476
E-mail: nknowles@usgs.gov
FAX: 650 329 4327

Noah Knowles

Education

2000 University of California San Diego, CA
Ph.D. Oceanography

1996 University of California San Diego, CA
M.S. Oceanography

1993 University of Illinois Urbana, IL
M.S. Physics

1991 University of Illinois Urbana, IL
B.S. Engineering Physics

Employment

2002-present U.S. Geological Survey Menlo Park, CA
USGS National Research Council Research Associate

Studying role of climate variability in estuarine contaminant fluxes, particularly benthic trace metal fluxes.

Analyzing vegetation's role in determining watershed response to climate variability and change using satellite observations and numerical models.

Investigating historical trends in runoff, snowpack, and precipitation form (rain vs. snow) across the Western U.S.

2000-2002 University of California San Diego, CA
Postgraduate Researcher

Applied estuarine and hydrologic models to assess the potential impacts of global warming in the San Francisco Bay-Delta estuary and watershed.

Studied dependence of meteorological and hydrologic processes on elevation in California in the context of climate variability and change.

Developed Statewide model of California hydrology.

1996-2000 University of California San Diego, CA
Graduate Student Researcher

Investigated seasonal to interdecadal variability of San Francisco Bay salinity and the hydrology of its upstream watershed using simulated and observed data.

Developed and applied new hydrologic modeling techniques to the San Francisco Bay-Delta watershed, resulting in the first combined model of the estuary/watershed system.

Delineated mechanisms by which climate variability propagates through the managed watershed into the estuary, and participated in interdisciplinary collaborations to investigate the ecological implications of such effects.

1993-1996 University of California San Diego, CA

Graduate Student Researcher

Studied nonlinear processes driving atmospheric circulation using numeric models.

1992-1993 University of Illinois Urbana, IL

Research Assistant

Developed and applied computer and analytical models of simple nonlinear systems. These studies had applications in fiber optic transmission, microelectronics and condensed matter theory.

Publications

Peer-reviewed

Knowles, N., Cayan, D.R., Peterson, D.H., and R.J. Uncles (1995). "Modeling and Predicting Intertidal Variations of the Salinity Field in the Bay/Delta." Interagency Ecological Program Newsletter **8**(Fall).

Knowles, N. (1996). Simulation and Prediction of Salinity Variability in San Francisco Bay. Scripps Institution of Oceanography. La Jolla, CA, University of California, San Diego.

Knowles, N., Cayan, D.R., Ingram, L., Peterson, D.H., and R.J. Uncles (1997). "Diagnosing the Flood of 1997 in San Francisco Bay with Observations and Model Results." Interagency Ecological Program Newsletter **10**(Summer).

Knowles, N., Cayan, D.R., Peterson, D.H., and R.J. Uncles (1998). "Simulated Effects of Delta Outflow on the Bay: 1998 Compared to Other Years." Interagency Ecological Program Newsletter **11**(Fall): 29-31.

Knowles, N. (2000). Modeling the Hydroclimate of the San Francisco Bay-Delta Estuary and Watershed. Doctoral Dissertation, Scripps Institution of Oceanography. La Jolla, CA, University of California, San Diego. http://tenaya.ucsd.edu/~knowles/html/SFBayHydroclimate.html

Stahle, D., M. Therrell, M.K. Cleaveland, D.R. Cayan, M.D. Dettinger and N. Knowles (2001). Ancient Blue Oaks Reveal Human Impact on San Francisco Bay Salinity. EOS: Transactions, American Geophysical Union, 82:12.

Knowles, N., 2002: Natural and Human Influences on Freshwater Inflows and Salinity in the San Francisco Estuary at Monthly to Interannual Scales. Water Resources Research, 38, 25-1 to 25-11. http://tenaya.ucsd.edu/~knowles/papers/knowles_wrr_2002.pdf

Knowles, N., and D. Cayan, 2002: Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco estuary. Geophysical Research Letters, 29, 38-1-38-4. http://tenaya.ucsd.edu/~knowles/papers/knowles_grl_2002.pdf

Cayan, Dettinger, Redmond, McCabe, Knowles, and Peterson, 2003: "The transboundary setting of California's water and hydropower systems--Linkages between the Sierra Nevada, Columbia, and Colorado hydroclimates", book chapter. http://tenaya.ucsd.edu/~dettinge/transboundary.pdf

Knowles, N., and D. Cayan, 2004: Elevational Dependence of Projected Hydrologic Changes in the San Francisco Estuary and Watershed. Climatic Change, 62, 319-336.
http://tenaya.ucsd.edu/~knowles/papers/knowles_cc_2004.pdf

In Review:

Knowles, N. and K. P. Georgakakos (2004). "A Describing Function Approach to Aggregating High-Resolution Land-Surface Data for Macroscale Hydrologic Modeling." Water Resources Research, **submitted**.

Selected Presentations

American Geophysical Union Meeting 1995-1998, 2002, 2004

Pacific Climate Workshop 1995-2003

Bay-Delta Modeling Forum 2000

Interagency Ecological Program Conference 1997

State of the Estuary Conference 1995, 1997, 1999, 2001

CALFED Science Conference 2000, 2002

Sierra-Nevada Science Conference 2003

California (CEC) Climate Change Conference 2004

Mountain Climate Sciences Symposium 2004

BIOGRAPHICAL SKETCH- BRUCE E. JAFFE

EDUCATION

University of California-Santa Cruz, B.S. 1980, Earth Science
University of Washington, M.S. 1983, Geological Oceanography
University of California-Santa Cruz, Ph.D. 1993, Earth Science,

RESEARCH AND PROFESSIONAL EXPERIENCE

1983-present	Research Oceanographer, US. Geological Survey
2000	Lecturer, University of California-Santa Cruz, Earth Sciences
1991-83	Research and Teaching Assistant, University of Washington

RESEARCH INTERESTS

My research focus is coastal geologic and physical processes. In recent years I have emphasized research on modeling and understanding the geologic record of catastrophic events (e.g., tsunamis, hurricanes and landslides). I have studied coastal areas on the Pacific, Atlantic, Gulf, and Great Lakes coasts of U. S., as well as areas in Peru, Puerto Rico, Samoa, Hawaii, Java, Papua New Guinea, and Guam.

Current Areas of Research:

- Historical sediment transport, sedimentation, and coastal change (projects: Project Chief and PI, Historical bay-floor and shoreline changes in San Francisco Bay)
- Paleotsunami interpretation and tsunami sediment transport (projects: Chief and PI, Tsunami Risk Assessment Project: Conducts research on tsunami deposition including studies of the 2001 Peru, 1998 Papua New Guinea and 1994 East Java, and 1700 Cascadia tsunamis)
- Nearshore sediment transport and hydrodynamics (projects: PI, Coral Reef Project: Conducts research on sediment transport affecting coral reefs in Maui)

SELECTED PUBLICATIONS SINCE 1995

Jaffe, B. E., and Rubin, D. M., 1996, Using nonlinear forecasting to determine the magnitude and phasing of time-varying sediment suspension in the surf zone: Journal of Geophysical Research, v. 101, no. C6, p. 14,283-24,296.

Jaffe, B. E., List, J. H., and Sallenger, A. H. Jr., 1997, Massive sediment bypassing on the lower shoreface offshore of a wide tidal inlet; Cat Island Pass, Louisiana: Marine Geology , v. 136/3, p. 131-149.

List, J. H., Sallenger, A. H., Jr., Hansen, M. E., and Jaffe, B. E., 1997, Accelerated relative sea-level rise and rapid coastal erosion: testing a causal relationship for the Louisiana barrier islands, Marine Geology, v.140, p. 347-365.

Jaffe, B. E., Smith, R. E., and Torresan, L. Z., 1998, Sedimentation and bathymetric change in San Pablo Bay: 1856 to 1983: U.S. Geological Survey Open-File Report 98-759.

Jaffe, B., Kayen, R., Gibbons, H., Hendley III, J. W., and Stauffer, P. H., 1998, Popular beach disappears underwater in huge coastal landslide—Sleeping Bear Dunes, Michigan: USGS Fact Sheet 020-98.

Gelfenbaum, G., Jaffe, B., Neal, T., and Davies, H., 2000. 1998 Tsunami: Papua New Guinea: InterCoast, vol. 35, p. 7-8.
Storlazzi, C. and Jaffe, B. E., 2002, Flow and sediment suspension events on the inner shelf in Central California, Marine Geology, v. 181(1-3), p. 195-213.
Gelfenbaum, G., and Jaffe, B., 2003, Erosion and sedimentation from the 17 July 1998 Papua New Guinea tsunami: Pure and Applied Geophysics, v. 60, no. 10-11.
Parsons, T., R. Sliter, E. L. Geist, R. C. Jachens, B. E. Jaffe, A. Foxgrover, P. E. Hart, and J. McCarthy, 2003, Structure and mechanics of the Hayward-Rodgers Creek fault stepover, San Francisco Bay, California, Bull. Seismol. Soc. Am., Vol. 93, No. 5, pp. 2187–2200.
Storlazzi, C.D. and Jaffe, B.E., 2003, Coastal Circulation and Sediment Dynamics along West Maui, Hawaii, Part 1: Long-term measurements of currents, temperature, salinity, and turbidity off Kahana, West Maui: 2001-2003, U.S. Geological Survey Open-File Report 03-482.
Marvin-DiPasquale M., Agee J., Bouse R., Jaffe B., 2003, Microbial Cycling of Mercury in Contaminated Wetland and Open-Water Sediments of San Pablo Bay, California. Environmental Geology, v. 43(3) p. 260-267.
Barnhardt, W.A., Jaffe, B.E., Kayen, R.E., and Cochrane, G.R., 2004, Influence of near-surface stratigraphy on coastal landslides at Sleeping Bear Dunes National Lakeshore, Lake Michigan, USA: Journal of Coastal Research, v. 20, no. 2, p. 510-522.
Jaffe, B., Gelfenbaum, G., Rubin, D., Peters, R., Anima, R., Swensson, M., Olcese, D. Bernales L., Gomez, J., and Riega, P., 2003, Tsunami Deposits: Identification and Interpretation of Tsunami Deposits from the June 23, 2001 Peru Tsunami, Proceedings of the International Conference on Coastal Sediments 2003, CD-ROM Publicshed by World Scientific Publishing Corp and East Meets West Productions, Corpus Christi, TX, USA. ISBN 981-238-422-7, 13 p.
Foxgrover, A.C., Higgins, S.A., Ingraca, M.K., Jaffe, B.E., and Smith, R.E., 2004, Deposition, erosion, and bathymetric change in South San Francisco Bay: 1858-1983: U.S. Geological Survey Open-File Report 2004-1192, 25 p. [URL: http://pubs.usgs.gov/of/2004/1192]Jaffe, B. E., Smith, R. E., and Foxgrover, A., in press, Anthropogenic Influence on Sedimentation and Intertidal Mudflat Change in San Pablo Bay, California: 1856 to 1983, Estuarine, Coastal and Shelf Science.

SELECTED WEB SITES

San Pablo Bay Historical Sedimentation and Bathymetric Change:
http://sfbay.wr.usgs.gov/access/sanpablobay/bathy/home.html

Peru Tsunami Deposits:
http://walrus.wr.usgs.gov/peru2/

Papua New Guinea Tsunami Deposits:
http://walrus.wr.usgs.gov/tsunami/itst.html

Curriculum vitae

ANDREA ROBIN STEWART

U.S. Geological Survey
Water Resources Division
345 Middlefield Rd. MS 465
Menlo Park, CA 94025
650-329-4550
arstewar@usgs.gov

EDUCATION

Ph.D. February 1998. Dept. of Botany University of Manitoba, Winnipeg, Manitoba.
B.Sc. May 1991. Dept. of Biology, University of Victoria, Victoria, British Columbia.

HIGHLIGHTS

- Eight International Conference on Mercury as a Global Pollutant 2006 – Planning committee
- Co-recipient of a 2.6 Million dollar grant from CALFED (September 2001-2004)
- Co-recipient of a 2.3 Million dollar grant from CALFED (May 2003-2006)
- National Institutes of Water Resources (NIWR) – U.S. Geological Survey (USGS) research competition review panel 2003
- Invited lecture at the USGS, Biological Research Division, National Contaminants Review, Washington 2002
- Invited lecture at Stanford's Civil and Environmental Engineering Department 2002
- Invited lecture at the State of the Estuary Conference, San Francisco 2001
- Plenary lecture at the Canadian Zoological Society Conference, Sudbury, Ontario 2000

RESEARCH & PROFESSIONAL EXPERIENCE

Research Hydrologist, USGS, Menlo Park, CA (April 1999 – Present)
Research area: ***Contaminants in the food web of San Francisco Bay and Delta***

- Evaluate feeding relationships in the food webs of San Francisco Bay and the San Joaquin Delta using stable carbon, nitrogen and sulfur isotopes. Investigate mechanisms and compare different pathways of trophic transfer of Se.
- Identify relationships between spatial and temporal flow patterns, sills and suspended sediments, clam energetics (e.g., growth and reproduction) and Se contamination in clams.
- Co-PI coordinating a team of geochemists, toxicologists, hydrodynamic engineers and modelers, and ecologists in a study to understand carbon and selenium transport and transformation (CASTT) in the Sacramento/San Joaquin Delta.
- Evaluate the pathways of mercury bioaccumulation using stable isotopes in the food web of the Camp Far West Reservoir, Bear River Watershed, CA.
- USGS National Water Quality Assessment Program (NAWQA) Topical Work Team for Hg. Advisor on a 3 yr study to assess the roles of food web structure, methylation efficiency and mercury source in determining national trends in mercury concentrations in top predator fish.

Postdoctoral Research Associate, Freshwater Institute, Dept. of Fisheries & Oceans, Arctic and Marine Contaminants, Winnipeg, Manitoba, Canada (February 1998 – March 1999)
Research area: ***Transport, Fate and Bioaccumulation of Persistent Organic Pollutants and Metals***

- Assessed the impacts of the 1997 Red River flood on the transport and fate of persistent organochlorine pesticides, hydrocarbons and metals (Cd, Se and Hg) and their accumulation in the food chain of Lake Winnipeg.
- Identified a new source of toxaphene released into the Red River during the flood and traced its transport and accumulation in the sediments and biota of Lake Winnipeg using high resolution gas chromatography/electron capture negative ion/high resolution mass spectrometry (HRGC/ECNI/HRMS) – one of 3 laboratories in North America with this technology.
- Related statistical increases in chlorinated benzenes (CBZs), PCBs and DDT in predator fish to changes in the partitioning of contaminants at the base of the food web.
- Supervised an analytical staff 9 employees.

Ph.D. Research Associate, Freshwater Institute, Dept. of Fisheries & Oceans, Ecotoxicology, Winnipeg, Manitoba, Canada (September 1991 – January 1998). Dr. Diane Malley (Supervisor)
Research area: ***Bioavailability/Bioaccumulation of Metals and Metal Mixtures***

- Determined the effect of a mixture of metals (Cu, Zn, Pb and Ni) on Cd fate, bioavailability and accumulation in a freshwater mussel (*Pyganadon grandis*) and a rooted macrophyte (*Eriocaulon septangulare*) using *in situ* mesocosm experiments at the Experimental Lakes Area, northwestern Ontario.
- Sampled and analyzed water, sediment, porewaters and biota. Analyses included water chemistry, metal analysis by graphite furnace atomic absorption spectrophotometry and flame atomic absorption spectrophotometry (including geochemical fractionation procedures) and biochemical analysis (e.g. metallothionein).

Scientific Consultant, Natural Resources Canada, Canadian Center for Mineral and Energy Technology, Aquatic Effects Evaluation Program, Ottawa, Canada (Fall 1996 – Spring 1997)
Research area: ***Environmental Effects Monitoring Using Biological Indicators***

Research Assistant, Freshwater Institute, Department of Fisheries and Oceans, Ecotoxicology, Winnipeg, Manitoba, Canada (Summers 1990, 1991, 1989 & 1988)
Research area: ***Whole-Lake Experimentation, Metal Toxicity & Biochemical Indicators in Freshwater Mussels***

Research Assistant, British Columbia Ministry of Environment, Water Research Branch, Victoria, British Columbia, Canada (Fall 1989)
Research area: ***Water Quality Assessment and Management***

Research Assistant, Department of Health and Welfare, Health Protection Branch, Ottawa, Ont. Canada (Spring 1989)
Research area: ***Environmental Health Assessment***

RESEARCH GRANTS

$2,262,567 CALFED. 2003-2006. *Evaluation of Mercury transformations and trophic transfer in the San Francisco Bay/Delta: Identifying critical processes for the ecosystem restoration program (ERP)*. Co-applicant with M. Marvin Di-Pasquale (USGS, CA), R. Mason (University of Maryland, MD), and N. Fisher (SUNY, NY).

$2,600,000 CALFED. 2001-2004. *Transport, transformation and effects of Se and C in the Delta: Implications for ERP*. Co-applicant with J. Cloern, L. Lucas, and J.Burau (USGS,

CA), S. Monismith (Stanford University, CA), M. Stacey (UC Berkeley, CA), G.A. Cutter and M. Doblin (Old Dominion University, VA), N. Fisher and S. Baines (SUNY, NY).

$90,462 SWRCB. 2001-2004. *Mercury methylation and bioaccumulation in reservoirs, sediments, and the food web of the Bear River watershed, California*.

$75,000. International Joint Commission Red River Task Force. 1998 – 99. *Contaminant issues of the 1997 Red River Flood*. Co-applicant with Gary Stern and Lyle Lockhart, Freshwater Institute, Winnipeg, Manitoba, Canada.

AWARDS AND DISTINCTIONS

NSERC Visiting Postdoctoral Fellowship in Government Laboratory. 1998-1999

Society of Environmental Toxicology and Chemistry (SETAC) Best Poster Presentation. 1996

University of Manitoba Graduate Fellowship. 1991-1995

Manitoba Society of Soil Science Conference - Best Student Poster. 1995

Australian Cooperative Research Center for Freshwater Ecology. National Postgraduate Scholarship 1993.

PUBLICATIONS

Stewart, A.R., Luoma, S.N., Schlekat, C.E., Doblin, M.A. and Hieb, K.A. 2004. Food web pathway determines how selenium affects aquatic ecosystems: A San Francisco Bay case study. Environ. Sci. Technol. 38:4519-4526.

Stewart,A.R., Stern,G.A., Lockhart,W.L., Kidd,K.A., Salki,A., Stainton,M., Koczanski,K., Rosenberg,D.M., Savoie,D.A., Billeck,B.N., Wilkinson,P., and Muir,D.C.G. 2003. Assessing trends in organochlorine concentrations in Lake Winnipeg fish following the 1997 Red River flood. J.Great Lakes Res. 29: 332-354.

Baines, S.B., N.S. Fisher, and A.R. Stewart. 2002. Assimilation of Se and trace metals from food in juvenile striped bass. Limnol. Oceanogr. 47: 646-655.

Stewart, A.R. and others. 2001. Applications of stable isotopes research in understanding complex ecological processes in the San Francisco Estuary. Interagency Ecological Program for the San Francisco Estuary. IEP Newsletter 14(4): 27-32.

Stewart, A.R. 1999. Accumulation of cadmium by a freshwater mussel (*Pyganodon grandis*) is reduced in the presence of other metals. Can. J. Fish. Aquat. Sci. 56: 467-478.

Stewart, A.R. and Malley, D.F. 1999. The effect of a metal mixture (Cu, Zn, Pb and Ni) on cadmium bioavailability and accumulation by the freshwater macrophyte *Eriocaulon septangulare*. Environ. Toxicol. Chem. 18:436-447.

Malley, D.F., A.R. Stewart and B.D. Hall. 1996. Uptake of methyl mercury by the floater mussel, *Pyganodon grandis* (Bivalvia, Unionidae), caged in a flooded wetland. Environ. Tox. Chem. 15: 928-936.

MANUSCRIPTS IN REVIEW

Croteau, M-N., Luoma, S.N. and Stewart, A.R. Trophic transfer of metals along freshwater food webs: Evidence of cadmium biomagnification in nature. Submitted to L&O October 18, 2004

CASCaDE: Computational Assessments Of Scenarios Of Change For The Delta Ecosystem: Signature

This proposal is for the Science Program 2004 solicitation as prepared by Cloern, James E.

2004-12-27: In response to user feedback, the project and conflict of interest forms have been corrected. Please read the current versions carefully.

The applicant for this proposal must submit this form by printing it, signing below, and faxing it to +1 877-408-9310.

Failure to sign and submit this form will result in the application not being considered for funding.

The individual signing below declares that:

- all representations in this proposal are truthful;
- the individual signing the form is authorized to submit the application on behalf of the applicant (if applicant is an entity or organization);
- the applicant has read and understood the conflict of interest and confidentiality discussion under the Confidentiality and Conflict of Interest Section in the main body of the PSP and waives any and all rights to privacy and confidentiality1 of the proposal on behalf of the applicant, to the extent provided in this PSP; and
- the applicant has read and understood all attachments of this PSP.

Proposal Title: CASCaDE: Computational Assessments of Scenarios of Change for the Delta Ecosystem

Proposal Number: 2004.01-0084

Submittor: Cloern, James E (jecloern@usgs.gov)

James E Cloern — 12-28-04

Applicant Signature — **Date**

JAMES E. CLOERN — U.S. Geological Survey

Printed Name Of Applicant — **Applicant Organization**